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THE FRENCH ARMORCLAD WAR SHIP BRENNUS.

THE armorclad ship Brennus was launched at Lorient on the 17th of October. This vessel, built under the superintendence of Mr. Huin, first class engineer of the navy, and after his plans, is one of the largest and most formidable war ships of the French navy. It is 357 ft. in length between perpendiculars, and 371 ft. in total length. Its breadth, exclusive of armor, at the load water line, is 66 ft. Its greatest depth is 60 feet. Its draught, with complete armament, will be about 25 ft.

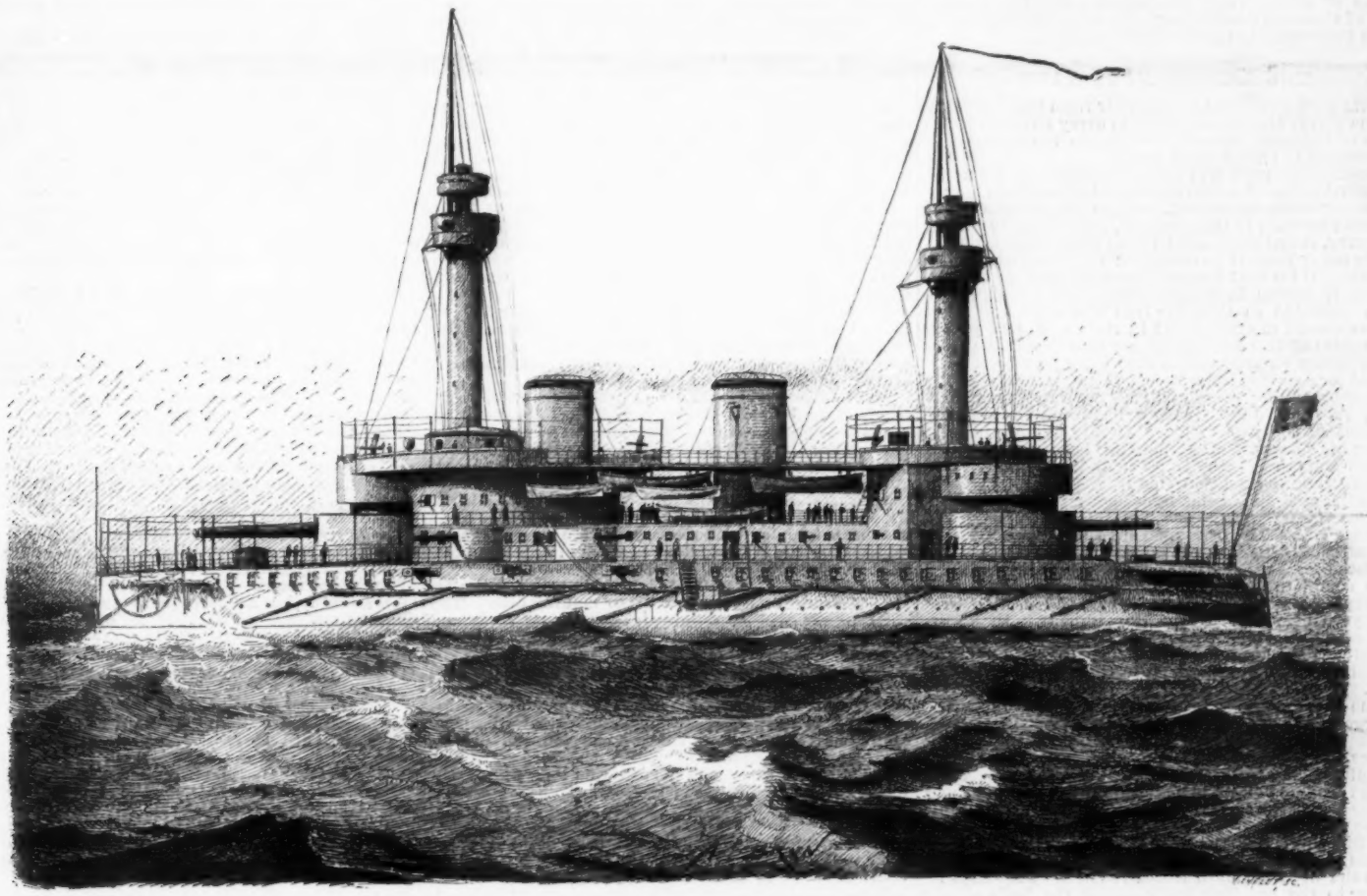
The Brennus is constructed wholly of soft and chrome steel, with the exception of the stern post and stem, which are of forged iron. The displacement of the ship will be nearly 12,000 tons. It has no ram, and the stem is perpendicular with the exception of a slight projection formed by the armor plate.

Like all the great modern war vessels, the Brennus has no sails, but merely two military masts. The foremast is surrounded by a trapeziform conning tower.

The protection of the vital parts is assured by an armor plate girdle, which extends from stem and stern, and, with the mattress of teak, forms a projection of 36 in., and by a protected deck 5 in. in thickness. Besides, the vessel is entirely encompassed by torpedo nets.

A central citadel, supporting four turrets, inclosing the jackets of the chimneys, is protected by plates of steel 4 in. in thickness.

The main artillery consists of three 10 in. guns, two placed in the forward turret and the third in the rear



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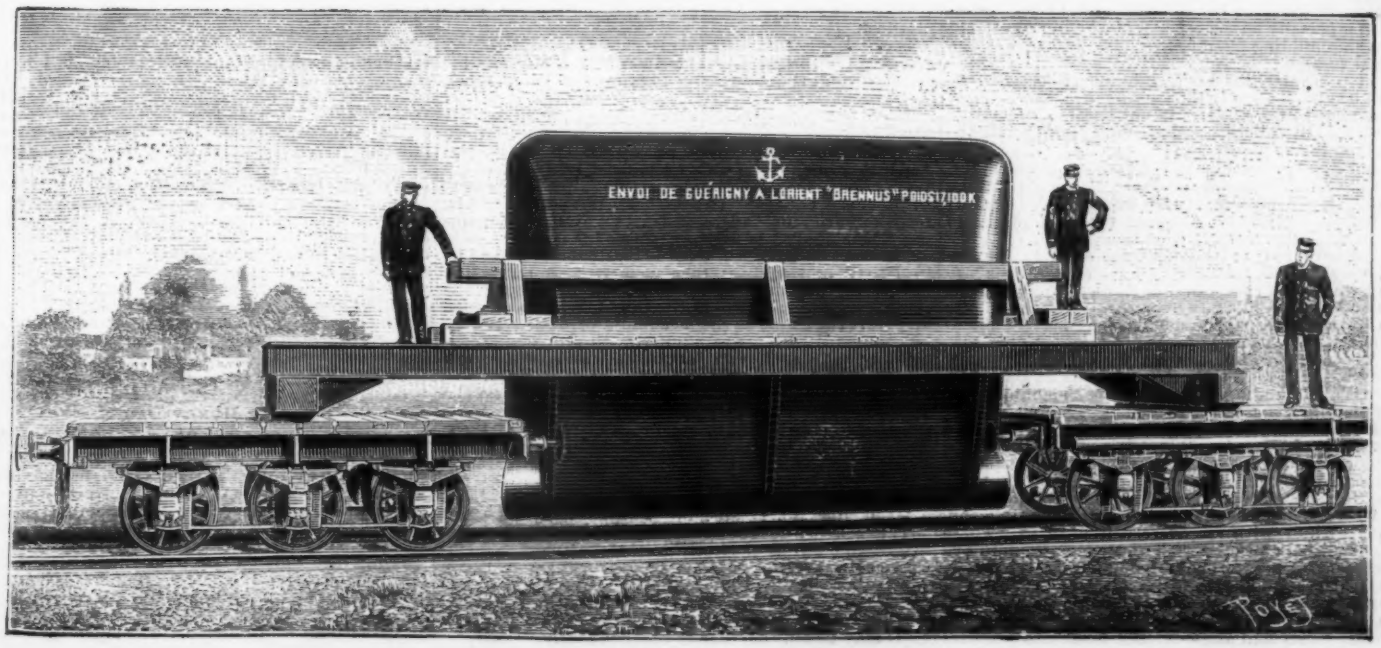


THE RUDDER OF THE BRENNUS.

one. These guns throw 990 pound projectiles with an initial velocity of 2,600 ft.

The secondary artillery comprises: Ten 6 in. guns, four 2½ in. rapid-fire guns, eight 1¾ in. ones, and eight 1¼ in. revolving guns. Finally, there are five torpedo tubes.

The engines actuate two screws, and will develop a power of 13,500 horses.—*L'Illustration.*

THE RUDDER OF THE BRENNUS.

THE national metal works near Guérigny (Nièvre), which, as every one knows, belong to the department of the navy, have recently sent an object to Lorient, by railroad, which must have puzzled those who saw it on the road.

It was the steel rudder for the ironclad Brennus, that has just been launched at Lorient. The unusual dimensions of this rudder, and its great weight, 17 tons, necessitated a special arrangement for its transportation, which was designed by the co-operation of the administration of the P. L. M. R.R. and the establishment at Guérigny. The rudder is 18 ft. high and 13 ft. wide, which made it impossible to place it on ordinary cars, and it was therefore suspended vertically between two strong platform cars, each supported on three axles and so arranged as to receive four heavy double T iron beams. It was held by a framework of iron and wood, and occupied all the available space between the roadbed and the arches of tunnels.

These enormous rudders are constructed, like modern vessels, with an interior frame of bars of wrought steel, angle irons, and plates, which is covered with plates of steel. Their manufacture requires a great deal of time and careful work, for when complete they must be absolutely tight.—*L'Illustration.*

THE BOSTON NAVY YARD.

THIS yard was closed by an order from the Secretary of the Navy, December 4, 1886, to carry out the resolutions of Congress, intended to reduce the expenses of maintaining so many navy yards.

The Boston yard was actually closed so far as its principal shops of construction of hull and marine engineering were concerned, but as it contained the largest ropewalk in this country, and the only one in the navy, it was necessary to keep that in operation.

For many years it has supplied the navy with all of its material for that purpose, from fishing line to hawsers of 27 inches in circumference, and its plant has been extended so that the iron wire rope and steel cables are all manufactured in its shops, and to-day the reader of this article can see two manila hawsers of 15 inches circumference, that have just been completed for securing the ironclad Texas, which vessel is fast approaching completion at the navy yard, Norfolk, Va. Mr. John Gardner has been the superintendent of the ropewalk for twenty-five years, and under his efficient charge there has been made rope of length enough to many times encircle the globe.

The original intention was to reserve this yard for the sole purpose of manufacturing the equipment articles required in the navy, such as anchors, chains, cooking galleys, ship pumps, steel cables, ropes, etc., but after all this was provided for, and these shops outfitted from other departments, there still remained such complete plants that the Boston yard still held its supremacy in having the largest and best tools of any yard belonging to the government. In an extent of eighty-five acres, there is fast approaching completely fitted shops, and all conveniently situated near building slips on an uninterrupted water front of 3,600 feet.

The dry dock, shears, wharves, etc., are under the charge of the civil engineer, the head of the department of yards and docks, as also are the tracks, mains, sewers, and repairs and construction of all yard buildings. Recently the railroad tracks connecting with the outside lines have been put in order, and new water pipes laid throughout the yard, with hydrants made to conform to the Boston City hydrants, in case the fire engines of the yard itself had more on their hands than they could safely control.

In the department of construction are the shops relating to the building and repair of the hulls of war vessels, and under Naval Constructor William Mintonye, U. S. N., comes the responsibility of the design of all work appertaining to the above, and also the docking of the vessels; it is the largest and the most important department in the yard, and to this office has been especially entrusted the converting of the old wooden shipbuilding plant to the requirements of the new steel vessels.

The shop for machine work of all kinds relating to the hull has been already thoroughly overhauled, and is in running order, under the supervision of Master Machinist J. H. Roberts, and several new tools have been added to the plant.

The old wooden bending mill has been lowered and completely renewed inside, and into this shop will be placed the larger shipwright tools, among them a heavy plate bending machine, designed for steel plates of 1½ in. in thickness by 22 ft. 6 in. long.

The rolls are four in number and of 32 in. in diameter, weighing 35 tons each. The center rolls are driven by a pair of compound engines. The outer rolls can be adjusted to give any curve to the sheet, and are driven by another pair of smaller engines for handling the rolls in making the adjustments. This machine will weigh complete over 200 tons, and is now building at the Bath Shipbuilding Works at Bath, Me.

There is also building a plate planing machine, capable of planing a sheet 24 ft. in length. The butt planer is to be capable of planing at any acute or obtuse angle within 10 degrees from a right angle. It will have a weight of about 40,000 pounds, and it will be placed beneath an overhead traveling crane.

Punching and shearing machines are also under contract, with a capacity of shearing and punching one-inch plates, and with an overreach of 30 in. These will be fitted with all modern improvements, and have jib cranes attached to them for handling the heavy sheets. There have also been already furnished a number of new planer bolt cutters and shaping machines, with radial drills, steam hammers, and special drills, and beam and angle-setting machines peculiar to ship work. This shop is also under the immediate supervision of master machinist Roberts, and all of the above are in addition to the original plant, placed there when the twin screw iron gunboat was built in 1873.

The sawmill has also been put in complete running order, and under the charge of Mr. Ezra Hursey, and is now engaged in sawing from live oak the foundations for the new tools. This live oak was cut many years ago from the government reservations in Florida, for the purpose of building wooden frigates, and is noted for its durability under all exposure and service. Some of it used as foundations in damp earth many years ago was recently removed, and found as firm and good as the day of its reception in the yard, over fifty years ago. The other smaller shops in the department of construction are also gradually receiving an overhauling that will make them ready for service. Naval constructor Mintonye was recently ordered to this yard for the express purpose of putting it in order, and has been ably assisted by chief draughtsman Jackson and general foreman Hichborn. The latter gentleman served his apprenticeship in the Boston yard, and worked for many years as journeyman and quarterman, up to his present place, and probably no one man in the yard better understands its needs and how to provide for them.

Before the closing of this yard the department of steam engineering possessed in its plant of machine shop, foundry, boiler shop, smithery and copper shop the most complete establishment under the control of the bureau of steam engineering. The machine shop possesses to-day the largest planer, slotter, lathe and boring tools in the United States, and with a full plant of all smaller machine tools in a condition to undertake any new or repair work. The shop has immense cranes and tracks for handling and moving work, and although without the convenience of overhead cranes, the arrangement is so complete that any large piece once received on its outer crane need not touch the floor until on the tool for which it is intended.

Notable among these tools is the large planer designed by the late Seth Wilmarth, master machinist, and was built in this yard; its weight is about 200 tons and the material used in its construction was old iron from the machinery of the Richmond and other war vessels; its cost was a near approach to $100,000.

The screw for one of the large planers is 42 ft. in length and was cut in a short lathe of 12 ft. bed, a small portion being cut at a time. It is six inches in diameter and was passed through a hollow head and tail stock, being moved on end as a section was cut, when the tool was again started.

The four large planers have respectively a width of 13 ft., 12 ft., 10 ft. and 8 ft. between the uprights; the larger planer moves on the ordinary V slides, but has also a transverse plaining motion. An attachment is also fitted for boring and slotting.

Among the cranes are two of hydraulic type, made from old cannon, and although built in 1868, are quite as efficient to the extent of their capacity as any of the modern type. The foundry is one of the largest in New England, having melting furnaces of 40 tons capacity, and cupolas of 15 tons capacity. Beneath its floors are large watertight pits capable of receiving the moulds of propellers up to 25 ft. in diameter. Connected with it is a brass foundry with overhead crane and all the requisites for the largest class of work of this composition.

Within this same building is now in progress the fitting of almost an entire new boiler making plant. The chief power will be obtained, both for its tools and cranes, from an accumulator maintaining 1,500 pounds pressure per square inch.

The largest of the tools will have separate hydraulic cranes connected with them. Among the tools will be an immense hydraulic riveting machine, so arranged that one person can place the sheets in position, and with a single lever control the triple hydraulic cylinder arrangement by which the sheets are first faced together, then the rivet driven, and finally the bar released. Its capacity will be for closing a steel rivet of 1½ in. in diameter, through three steel plates of 1½ in. thickness each. It will take a plate 124 in. wide, and be capable of riveting up a boiler 16 ft. in diameter. Connected with the tool is a hydraulic crane of 30 ft. in height. The pressure on the rivet will be variable from 35 to 75 tons per square inch. It will be complete for all sizes of rivets, and will have a supplementary attachment for light work. Above this tool is the hydraulic crane, having a hoist of 35 ft. and an overhead travel of 20 ft. in two direction, the whole to be controlled by one man from the operating platform.

There is also under contract a sectional flanging machine, furnished with two vertical rams, one for flanging and the other for turning the sheet down on the former.

There is also a horizontal ram for squaring up the plate against the block. The hydraulic cylinders are of bronze, and the horizoatal reach is to be 48 in., and vertical gap of 60 in. and exerting a pressure of 100 tons. With this tool the hydraulic hoist will consist of jib crane, sufficient to raise 5,000 pounds, and 18 ft. length of arm, and operated from an accumulator under 1,500 pounds pressure per square inch.

This accumulator will be of 12 in. diameter and 14 ft. in length, and will be furnished with an automatic device for maintaining the pressure, by closing the pump connections when at the top of stroke, and open and start the same as the accumulator falls. It is to be connected with a steam pump with all packings externally adjusted and accessible, and will work smoothly and noiselessly under the heaviest duty.

New shears and punches are also being built for the shops. Each of these tools will be operated by independent double cylinder engines. The reach of these tools will be 48 in., and be capable of shearing 1⅛ in. steel plates, or of punching a fair two inch hole through the same.

The new rolls will have a strength sufficient to bend a 1¼ in. steel plate of 10 ft. in width

The rolls will be of steel and 18½ and 20 in. in diameter, and will be perfectly counterbalanced to facilitate removal.

They will be operated by independent engines, and the bending roll is adjustable from the feed rolls by double cylinder engines, so arranged that the two ends may be fed together or independently.

Among other tools will be the largest boiler shell drill yet made. Every hole in the boiler shell will be drilled by placing the shell horizontally on the bed, which is so fitted as to be rotated by power. There will be four power drilling heads on crossheads moving vertically and horizontally, so as to drill the holes central to the boiler axis or at the angle required.

The vertical traverse is 8 ft. and the horizontal traverse is 12 ft., and the tool is to drill by automatic feed through 1⅛ in. plates, holes of 2⅛ in. in diameter.

There is also in connection with the steam engineering department a large pattern shop, having a capacity for employment of about 30 men, and with the exception of a few minor tools is ready for work.

Power for this building is furnished by a horizontal engine 18 in. diameter cylinder and four feet stroke, and there are about completed three new steel horizontal boilers of 125 horse power each. The chimney connected with this shop has a height of 239 ft., and has been a subject of great interest in the repairs that have been made upon it without the aid of any staging.

The department of steam engineering is under the control of Chief Engineer Alexander Henderson, U. S. N.

Next to the large machine shop and the main boiler house is the smithery, having a capacity of four steam hammers, and about 24 double forges. It is now in active operation in the manufacture of anchors and chain for the new cruisers. The anchors now building have a weight of about 4,500 pounds, and the chains are of 2⅛ in. diameter of iron and capable of resisting a strain of 91 tons.

In connection with the smithery are a complete set of bolt and nut forging machines, capable of making bolts varying from one-half to two inches in diameter, also a rivet machine, with a capacity of about 5,000 rivets per diem.

A new testing machine of the Reihle pattern has just been fitted in this shop, and in some recent tests the material made at the yard has reached a tensile strength of 52,000 pounds pressure to the square inch. Connected with the same department is the rolling mill. The scrap from the various navy yards is shipped here, and is carefully selected for making the iron for chains. This mill is fitted with large shears driven by an independent engine, with steam hammers capable of forging a shaft of 15 in. diameter, and with a complete outfit of heating furnces and trip hammers. It is in daily operation now on work for the new cruisers, and both the chain shops and rolling mills are under the control of and especially supervised by Mr. Samuel Dwight.

The department of equipment also includes a separate machine shop, well equipped and now in operation in the manufacture of steam galleys, pumps, etc., for the new ships, and connected with it is a small foundry for supplying the small castings of brass or iron necessary for those purposes. New boilers are now being prepared for this building, arranged for its various shops and heating the adjoining building. They will be about 300 horse power. In the same building, under the control of the department of yards and docks, are the shops for the repairs of all gas, water and heating apparatus in the yard. The various shops of the bureau of equipment are under the charge of Commander B. F. Day, U. S. N.

Connected with the various manufacturing departments of the yard is one general storehouse, under charge of Pay Director Parks, U. S. N. Formerly each of the shops required and kept the custody of its own stores, and it was no infrequent occurrence for a purchase of material to be made for one shop, when another department could easily spare the articles. In addition to the extra expense attending the old system, it often occasioned vexatious delays.

At present all requisitions go to the general storehouse and are provided from the paymaster's department, if they are in the yard. An additional pay director, Edward May, U. S. N., is stationed in Boston, from whose office all purchases in the open market, contracts for material, etc., are issued.

By a recent order from the Navy Department, emanating from the Assistant Secretary of the Navy, James R. Soley, there has been a radical change in the manner of labor employment. The principal object of this order has been to eliminate the political influence that has so long been a detriment to efficiently carrying out the work, and also to enforce the several acts of Congress giving the preference to those workmen who have been in the military and naval service, provided they are equal in skill and efficiency. The new regulations strictly prohibit any assessments for political purposes, or either employment or discharge for political opinions.

These regulations went into effect on September 1, and require all applicants for employment to register in person, with references regarding sobriety and character, and if mechanics, regarding their skill in the trade sought. Selections are made in the order of application, and while the head of the department may not require the service of any particular person, he is at full liberty to recommend the discharge of any employe sent him, either for incompetency, idleness or good cause, and this register prevents his employment in any other department. Foremen and quartermen are especially examined by a board of officers, and are appointed by the navy department. The good effect of this law has already manifested itself, and there appears no doubt but that as soon as it is in good working order, its good influence will be felt not only by the employes, but in reducing the cost and time in doing work.—*Manufacturers' Gazette.*

SINKING WELLS AND SHAFTS.*

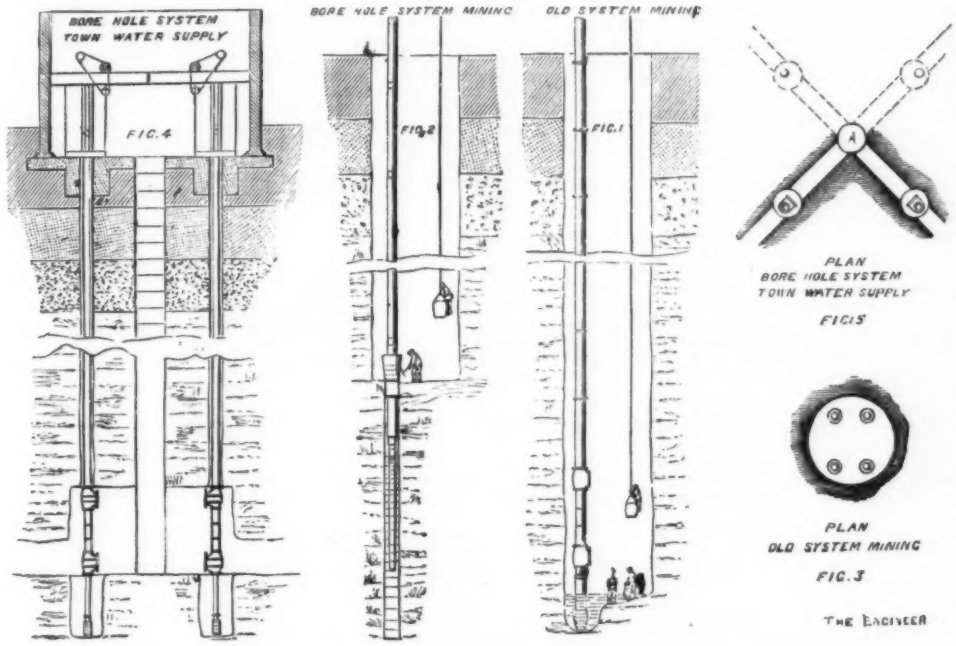
By HENRY DAVEY.

IN 1881 the president of this section, Mr. Forster Brown, with Mr. Adams, read a paper before the Institution of Civil Engineers on deep mining of coal in South Wales. In that paper the authors pointed out the great difficulty and expense attending the sinking of shafts through water-bearing strata, and suggested that a boring might be put down in advance of the sinking into which a pump might be placed to facilitate the operation of sinking. The water being pumped down in the boring below the bottom of the shaft, the sinking would be done in dry ground, and would go on without intermission. The suggestion appeared

* Paper read at the Cardiff meeting of the British Association, mechanical science, Section G.

to be a valuable one. In sinking shafts and wells through water-bearing strata, on time honored methods, there is not only the great cost, but, what is often more serious, the great length of time taken in doing the work. A single well for town water supply often takes two or three years or more to execute. The subject is of considerable local importance, because of its bearing on the sinking of mining shafts, and it is on that account that the author ventured to bring it briefly before the association. The problem is simply that of keeping down the water in water-bearing strata in advance of the sinking operations, so that the excavation of the shaft or well shall be done in dry ground. The ordinary method of shaft or well sinking is to sling a pump or pumps in the shaft and to lower the pumps from time to time as the sinking continues; obviously the excavation has to be performed in water, and if the quantity of water to be dealt with is very great, a large portion of the work has to be done by the men working in a depth of two or three feet of water. To facilitate the work and to reduce the water in which the men have to work, a sump is made under the suction pipe of the pump, and it is the keeping this sump excavated in advance of the other work which is most difficult and tedious. Then there is the delay occasioned by the lowering of the pumps, and providing the appliances necessary to the operation.

In the plan now proposed, the pump would be placed in a borehole made before the commencement of the sinking of the shaft. The only novelty in the pump is that of adapting it to the purpose. It is necessary that *debris* shall not go down the borehole in quantity sufficient to choke it up. That is provided against by means of a heavy taper shield of cast steel surrounding the pump and resting on the edge of the borehole. This shield is perforated with holes inclined upward toward the pump to allow water to get into the borehole, but to exclude *debris*. The shield is made very heavy, and by its own weight follows the excavation around the pump, and also protects it from injury through the blasting of the rock. The pump is made without a foot valve, the rod of the bucket working



DAVEY'S SYSTEM OF SINKING WELLS AND SHAFTS.

through the seating of a valve which rests on the top of the working barrel; by this arrangement the drawing of the bucket also draws the valve, and should the bottom of the borehole be filled up with sand, it can be removed by lowering a sand pump such as is used in making boreholes. The boreholes should be made to a greater depth than that required for the pump, to provide a space for sand and *debris*. The application of this pump to the sinking of shafts would be varied to suit the local circumstances and the geological formation of the strata to be passed through. Details of various applications which might present themselves are omitted. It is quite evident that in some situations the shaft might be drained by means of boreholes outside, and this is a plan now being carried out in procuring water for town water supply.

It is the usual and necessary practice to provide duplicate pumping engines, and where two engines are made to pump from the same well, the well must be very large, that it may accommodate two sets of pumps. Such wells are usually 12 feet to 14 feet in diameter. To sink such a well in the ordinary way is a very long and costly undertaking, especially if quicksand is met with. On the completion of the well it may be necessary to drive adits to increase the water supply. A simple borehole is made very cheaply and very expeditiously—four 30 inch boreholes can be put down in a very small fraction of the time required to sink a 12 foot well in the ordinary way. Instead of making a large well the author puts down four boreholes to accommodate the pumps for duplicate pumping engines—a pair of pumps to each engine. The boreholes being completed, the pumps are lowered into them, and coupled up to the permanent engines. Immediately that is done the water found in the boreholes can be pumped and supplied to the town. Should it be insufficient, then a small well would be sunk in the dry to the bottom of the borehole pumps. The boreholes at the level of the pumps would be connected to the center well, and adits driven to collect more water. Should the boreholes yield sufficient water, there would be no necessity to sink the well. It would be absurd to advocate any particular system of well sinking as being universally applicable and expedient. This system of making wells and shafts certainly promises advantages under ordinary conditions; but the advisability of its adoption in any particular case must be a matter of judgment with the engineer planning the work. It may be of interest to know that the practice of "dowsing" for finding water is not altogether extinct in the West of England.

NEW METHOD OF TRANSFORMING HEAT INTO MECHANICAL ENERGY.

By Dr. HERMAN MEHNER.

ONE of the recent patents granted by the United States is for a "Method of Transforming Heat into Mechanical Energy," covered by about a dozen claims. U. S. Patent No. 456,831.

FIRST CHAPTER.

I.

This patent is of unusual importance, but as the subject treats on the most subtile theories of natural philosophy, it is best explained by means of an experiment.

Consider the behavior of water under the influence of heat, for example: Take one kilogramme of ice, at temperature —10° Cels.; put it into a suitable vessel and place an alcohol lamp under it. The amount of heat necessary to increase the temperature of water one degree (1° C.) is called *the unit of heat*, or calory.

The lamp is burning under the ice, and let us suppose that no loss of heat takes place through radiation. Then the sinking of the alcohol level shows the units of heat produced.

The temperature of the ice is necessarily rising on account of the heat from the lamp. When the thermometer in the ice marks exactly 0°, the level of the alcohol ought to show that five units of heat have been produced.

The lamp continues burning. Five more units of heat are generated, but the thermometer does not move; the lamp shows that 10, 15, 25 units of heat are generated, and still the effect upon the thermometer equals 0. What does this mean? The natural order of things is different from our supposition. The effect of the entering heat is the melting of part of the ice; the thermometer shows no change, that is, the temperature has not increased. This state of affairs lasts until 80 units of heat are produced, and by this the whole kilogramme of ice is melted. Thus, 80 units of heat are absorbed by one kilogramme of ice without any increase of temperature.

These 80 units of heat—or calories as the scientists call these units—are not lost. If the kilogramme of water of 0° C. should be carried to Siberia or Greenland, it would act like a heater, giving out heat to the colder surroundings, not changing in temperature, but after the 80 units had been given out, the water will again have been changed into ice, that is, the liquid would have become a solid. On this account, this kind of heat is called *latent heat*.

Now, to return to our apparatus. It contains one kilogramme of water of 0° C. just as it had contained ice of 0° C. before. But now each calory generated by the lamp warms the water 1°, that is, 80 calories would warm the water up to 80° C. and the next 20 calories would raise it to 100° C.

Now a similar state of things occurs as at the melting of the ice, the lamp continues to generate calories of heat, the temperature of the water *remaining* at 100° C., and steam is produced, that is, the water boils. The thermometer remains constant in the *boiling* water, until all has been transformed into steam, and with this transformation 540 calories have been consumed. Those 540 calories are latent heat of steam. They reappear in condensing the steam, as every steam heater shows.

II.

This latent heat is the expensive part of the steam engines of our days. The latent heat must be induced *into the boilers* in order to generate the steam and it is blown into the air, when this steam, after having performed its work, is exhausted, or it is transferred to the cooling water, when the steam is condensed.

An example for this is, in a steamboat about 55 kilogrammes of cold water enters the condenser for each kilogramme of steam which passes the engine, and they leave the condenser about 10° C. warmer, carrying away each 10 calories.

What that means, will be seen from the fact, that all the fire under the boilers, if employed directly to heat this cooling water, could give only an increase of 11° to this quantity of water. The slight difference, this trifling one unit of heat, is all that is employed usefully in the steam engine. It is, indeed, quite familiar to engineers, that the expensive colossal fires used in the modern steamers are kept up principally for the purpose of warming the ocean.

A modern steam engine, which acts in this way, is certainly not ideal, but it is a depressive thought, that the *ideal* steam engine is a hopeless thing. If the present improved steam engine transforms about 10 per cent. of the applied heat into mechanical work (motive power), the maximum that might ever be reached would be about 20 per cent. This is derived from the principles upon which the steam engine was constructed, that is, heat must be carried out of the engine (Sadi Carnot's principle), steam must be blown into the air or condensed by circulating cooling water after having acted.

Therefore a new epoch appears in engineering (and in civilization, too) when an invention has been made discarding those principles.

III.

The main feature of the invention is to keep the latent heat in the system of the engine as latent heat. The principle is carried into effect by the fact that the latent heat of condensation, that is, this heat which reappears if steam is transformed into water, can be neutralized by a latent heat of liquidation by an absorption like that which occurs when one kilogramme of ice in melting absorbs 80 units of heat without any change of temperature. Similar absorptions are numerous and well known to physicists.

One kilogramme of saltpeter, for example, in dissolving takes up 78 units of latent heat. This heat reappears like other latent heat in the inverse process, when the salt is separated from the solvent. Now, put into the condenser of a steamboat engine a certain amount of saltpeter. The saltpeter will dissolve in the water of condensation, binding heat.

Imagine the temperature inside of the condenser being kept at 60° C., as is often the case, then each kilogramme of newly formed water will dissolve one kilogramme of saltpeter, and 78 calories of the 540 calories of the latent heat of the steam will be kept latent on account of the liquefying salt, and of the 55 kilogrammes of cooling water which carries away heat from the engine, about 8 kilogrammes become unnecessary. The 55 kilogrammes of cooling water were used to take up the 540 calories, which are insensible heat in the steam, and appear in the change from the gaseous to the liquid form. If the 540 calories should not be taken away by the 55 kilogrammes of water, the steam would remain steam and the cylinder of the engine would not become emptied, so that the engine would get stuck. Now, 78 calories from the 540 are taken away, instead of by water, by salt, which needs them for changing from the solid to the liquid form. That is, about the seventh part of 540 calories, and therefore about the seventh part of 55 kilogrammes of cooling water, about 8 kilogrammes are not necessary. As the 78 calories are not thrown away they are kept, and soon reappear. When the solution is evaporated in a suitable boiler steam is formed, saltpeter becomes solid like the salt crystals in the pans of salt works, giving out the reappearing latent heat, which is very welcome for the supply of the great latent heat of the steam. This great amount of heat is taken up in the boiling process without any effect on the thermometer. The solidifying salt acts heating, saving fuel for the corresponding amount. It was pointed out before that a steam engine which passes through the condenser 55 kilogrammes of cold water for one kilogramme of steam throws out 90 per cent. of the received heat. If such a machine runs in the described way with saltpeter, saving from 55 kilogrammes about 6, this saving is a greater amount than is transformed in mechanical work during the same operation.

Now this result is only the theoretical beginning.

If the water of condensation is warmer, it dissolves much more saltpeter. Therefore, condense in a higher temperature.

For example, cool the condenser down only to 113° C., and the kilogramme of condense water dissolves about 3 kilogrammes of saltpeter, so that the solution stores up for repeated use over 200 units of heat. Thus it follows that the efficiency of such an engine would be double that of the ones now in use.

But this is not the final result.

By applying a temperature of 130°–140° C. about 7–8 kilogrammes of saltpeter are soluble and all the residue heat of the exhausted steam can be absorbed and used over and over again, so that only that part of the heat which is transformed into motive power must be induced into the boilers. No cooling water being in use, no heat is carried away. The thermodynamical efficiency of the engine is equal to 100 per cent.

The described effect of the saltpeter in the water of a steam engine is only an example for the new principle. Other applications of this principle are characterized in the patent mentioned.

It would be out of place to explain them all here. The theoretical engineer will be able to find them out for himself, taking the saltpeter process as his basis to work from.

The conclusions thus arrived at are astonishing.

SECOND CHAPTER.

I.

No cooling water is necessary for the condensation of the exhaust of steam engines. Draw the consequences.

Suppose a steamer sails from the Northern Ocean to the equator. In order to maintain the same low temperature in her condenser of the present system, the pumps for cooling water must work more and more the further south she gets, in order to pump more

and more water over the condenser, as the condensation depends upon the temperature of the surroundings.

On the contrary, condense after the new principle with the use of saltpeter, and the pumps for circulating ocean water come to a standstill. The engine is in no way affected by the change of the outer temperature. You might go to a boiling hot sea—if there were one—and the condensation would go on undisturbed, where an engine constructed on present principles would stop. The saltpeter condenser needs no communication with a cooler outside; on the contrary, the engineer will insulate his condenser thermically as perfectly as possible with mineral wool, as only heat could come from without, and this would melt saltpeter uselessly.

Imagine, for the sake of explanation, a sail to Jupiter. The atmosphere on this planet has about the same temperature as the air under our modern boilers. Make this atmosphere pass under the boiler, and you need no fuel. The condensation, however, goes on undisturbed, the saltpeter acting with the condense water as a cooling mixture.

It seems very peculiar to run an engine without any fuel, but there is nothing wonderful in it. Like in the same engine when it was still fired, steam is produced with a high pressure, by high temperature in the boiler, which steam delivers mechanical work (power) by expanding and disappearing into a place, the condenser, with low pressure and low temperature.

The whole difference lies in the change of external conditions. It is the low temperature of the condenser which enables any engine to run, by removing, after the stroke, the steam which has done work. In the engine of to-day, this low temperature is not made, but taken as nature offers it, and the necessary higher temperature must therefore be artificially made by a chemical process (burning fuel); in the newly described engine running on the hot planet it is the *high* temperature which is offered by nature and the *low* temperature which is made artificially by a chemical process (combining water with saltpeter). In our present system it is the generator of the high temperature, the boiler, which is protected against radiation as thoroughly as possible in order to save the chemical (fuel); on the hot planet, radiation would cause a loss of chemical in the generator of low temperature, the condenser.

This investigation demonstrates the general condition for running an engine without fuel: Produce a vapor of a suitable pressure by the temperature which nature offers and condense it after expansion to a low pressure by a lower temperature which is the result of a chemical process.

II.

The conditions in which the steam engine would run without fuel on a hot planet can be realized for engines on the earth with other vapors.

All vapors which are used in refrigerating machines have a pressure at the temperature of the atmosphere approximating that of steam in a boiler at its higher temperature. Furthermore, they are solvents for many solid substances.

Take for example methyl ether.

This is a fluid which boils at —23 C. as water does at 100° C., and has at ordinary temperatures a pressure of 5 atmospheres. That is the state which steam has in a boiler with 75 lb. pressure to the square inch, and a temperature of 300° Fah.

Other fluids, like anhydrous ammonia, now extensively used in ice machines, or ethylene, carbonic acid, etc., have a much higher pressure.

A methyl ether machine, therefore, can be run at ordinary temperature without fuel, provided that the vapor which comes from the unfired boiler with high pressure after having done work in expanding can be taken out of the engine by condensation at the corresponding low temperature.

Heretofore this was impossible because the only means known to make and maintain this necessary low temperature was the refrigerating machine.

It is theoretically demonstrated, however, and shown by experience, that any system of ice machine would consume in the ideal case as much work (power) in producing the low temperature as could again be reproduced by the aid of said low temperature. To combine these two machines in order to produce the low temperature by mechanical work, would be exactly as foolish as trying to produce the heat for a steam engine by mechanical work; for instance by compressing air, instead of by chemical means. Scientists have proved by the same demonstration as that concerning the use of the ice machine that in the ideal case the result would equal zero. For this impossibility to condense vapors like methyl ether at low temperature, without expense of mechanical work, their application in order to construct unfired prime motors for producing mechanical work could not be attempted heretofore.

But now, according to the newly invented principle, a suitable chemical way for making the low temperature is open.

Treat the methyl ether like the water in the steam engine built on the new principle, that is, dissolve in it such a solid substance as will form with it a cooling mixture, as did saltpeter with water. Such a substance is, among others, crystallized acetic acid. The vapor of methyl ether will thus be condensed, neutralizing its latent heat against the latent heat of the dissolving solid. The solution will then decompose itself again into the crystallized substance and vapor of methyl ether of a suitable pressure, if brought into a boiler (suitably constructed) of atmospheric temperature.

In case vapor of ammonia or certain other volatile substances which have a sufficiently great pressure at temperatures as low as the freezing point of water were used, the boiler for the new engine might even be heated by freezing water.

Ice is thus for the first time produced in a reasonable way. The surplus energy of the water, represented by the 80 units of latent heat mentioned at the beginning of the first chapter, is used as mechanical power, while heretofore in order to make ice, that is water minus energy, costly mechanical energy was consumed.

It is easily understood that any boiler, which is not fired, of a temperature higher than the freezing point and not forming ice, must of necessity reduce the temperature of the surroundings, producing cold for nothing by transforming heat into motive power.

The engine *must* make cold; for, if it did not, the mechanical energy would come from naught and there would be perpetual motion, which is impossible.

But, though perpetual motion is impossible, this engine has all those qualities which made the perpetuum mobile so eagerly sought for; it delivers an unlimited amount of motive power without expense of money; it is *not physically* but *economically* a perpetuum mobile.

DRAUGHT AND HAULAGE OF ROAD VEHICLES.

THE draught and haulage of vehicles by horses have often during the present century formed the subjects of experimental investigation or of investigation and writing without experiment. The best angle of draught has most frequently been the subject of treatment. The practical outcome of all this has not been much, if measured by relief to horses or in the increased load which a horse can haul. A new way of looking at the question, or a new method of treating it and experimentally investigating it, has been adopted by Mr. T. H. Brigg, of Bradford, whose work, *The Engineer* says, has resulted in a practical system of draught attachment by which he claims that horses are much relieved. This system of draught attachment has now been before the public for two or three years. It was exhibited in its various applications at the Doncaster meeting of the Royal Agricultural Society, but as some of the problems necessary to an explanation of the apparatus are not readily understood, the scant time in which the judges of the miscellaneous exhibits must arrive at a conclusion was not sufficient to enable them to deal with the apparatus.

It is not in the least likely that customs so old as those that relate to the form and position of horse attachment to vehicles will be readily admitted to be seriously in error, either by the public or by those who have been accustomed to build vehicles or make harness. In spite, however, of the fact that such enormous numbers of horses are attached to vehicles every day, and that intelligent and educated men have given their attention to draught questions, some of the most important points in a solution of the problems involved have escaped attention. Engineers are as much interested in them as any other employers and users of horses, and we may, therefore, draw attention to a few points in Mr. Brigg's arguments, and to the apparatus which has been made as a result of his investigations.

It has been usual in considering draught questions to settle upon an angle of draught and point of attachment by reference to the vehicle separately from the horse, assuming the tractive power of a horse to be represented by an abstract, mechanical pull along a line which may appear to be best. This has led to error. The horse and the vehicle must be considered together, the vehicle as varying in resistance with its load, the character and inclination of the road, and therefore varying as to the line along which that resistance may be best balanced by a pull. The horse must be considered as a set of weighted levers brought into more or less powerful action by variable muscular effort, and acting with more or less mechanical efficiency in proportion as they are, as weighted levers, enabled to act along a line or in a direction in which resistance to their movement is least.

The line of least resistance of the vehicle, and the line of greatest pull by the horse, are, therefore, both very variable, and there is no fixed best line of draught. Hitherto it has only been possible to work on a best mean line of draught. Now Mr. Brigg claims that it is found that it is possible to cause an automatic correspondence between the angle of draught, the hauling power, and the resistance to traction through a wide range of variation.

An illustration of this is afforded in the most simple manner by an explanation of Fig. 1A, which represents a man pulling at a wheel loaded with 336 lb. F represents an obstacle over which the wheel is to be hauled. It is obvious that the line of least draught will be in the direction A G, at a right angle to the line of resistance A F. A pull along this line of 150·3 lb. would move the 336 lb. As, however, the man cannot pull along the line A G, but along a line A B, he necessarily pulls at a disadvantage, part of his effort being lost in a downward thrust along the line A F. The result is a pull of 165·5 lb. is necessary to overcome the load. If the pull, though applied at A, could be made to act in the direction B E, parallel with the line G A, this disadvantage would be removed. This cannot be done, because by a pull of 150·3 lb. at B in the direction B E, a lifting effort would be experienced at B of 62 lb., and the trace would try to take the position G A. A parallelogram B J H K, of the forces involved, when the 150·3 lb. is exerted along the line B E, shows that a horizontal pull of 124 lb. represented by the length B J, and a downward pressure of 62 lb. represented by B K, would have a resultant pull of 150·3 lb. along the line G A.

By transferring 62 lb. of the load on the wheel to the man's hands at B, this result would be realized. That is to say, the load to be lifted over the obstruction at F would be reduced by 62 lb., the man's weight would not be reduced by an upward tendency, K B, the pull would be exerted along a virtual line B E, and the man would be in the same position with regard to the hauling of the load as he would be if raised on a platform so as to pull along the line G A. It will be

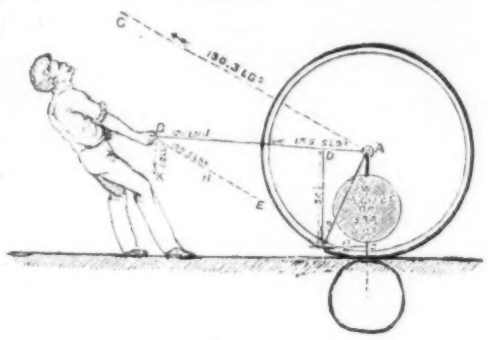
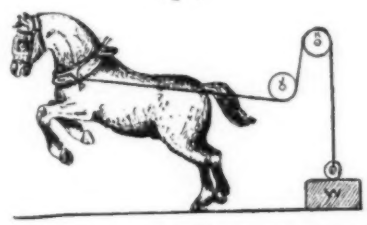


FIG. 1A.

seen from this that the best angle of draught depends upon the height of the obstacle to be overcome, whether that obstacle be a stone or a hill, or is made by the sinking of the wheel into the ground. It will also be seen that if the trace could be connected to the vehicle, so that it took the direction B E instead of B A, the wheel and its load could be hauled over the obstacle or up the hill with the pull of only 150·3 lb., without the transference of the 62 lb. This, however, cannot be done with a two-wheel cart, because such an attachment would cause the tilting rearward of the load and an upward lift of the shafts, which would reduce the weight of the horse on his legs, and thus destroy the otherwise useful effect of the low attachment. A familiar example of this is afforded by the practice of careful carters of putting the load in a cart forward when going up a hill or of hanging on the shafts so as to increase the weight on the horse's feet, more especially on the fore feet.

The low attachment can, however, be applied to

Fig. 4



four-wheeled vehicles, but without some means of automatically varying the effect of the constantly downward pull, whether the vehicle be on a hill or on a level, only part of the value of a low attachment would be realized, while in some cases the relief given to the horse on the heavier work would be neutralized by the fatiguing effect of the constant downward resultant of the low-angled pull during all work. To illustrate some of these things we may refer to the accompanying illustrations.

In Fig. 1 a horse is attached by a short trace to the equivalent of a loaded vehicle, namely, a weight W. With this short trace the angle is such that it departs only a few degrees from the line of action of the horse's weight when pulling, as shown by the line P O, Fig. 2. Hence but a small part of the horse's pull

Fig.

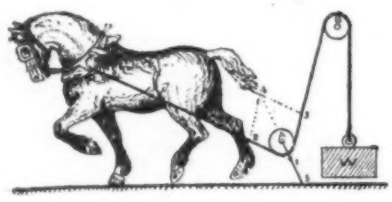


Fig 2

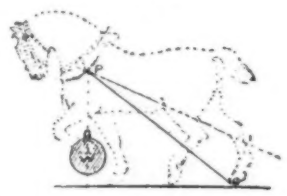
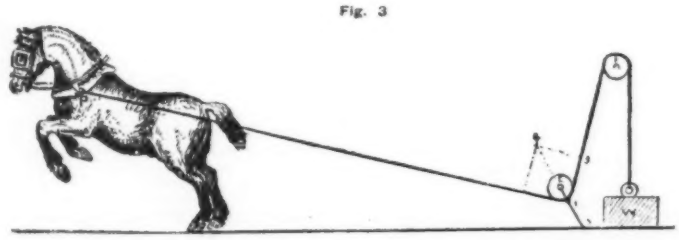


Fig. 3

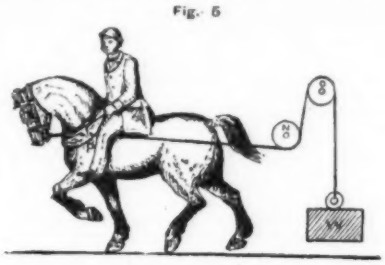


is lost in a tendency to lift weight off the fore feet and to cause the horse to rotate on its hind feet. When the horse is attached by a long trace, as in Fig. 3, the angle becomes greater, approaching the horizontal, more of the horse's weight is lost, and it becomes insufficient, as depicted in Fig. 3, to raise the weight. The conditions with a horizontal trace in Fig. 4 are approached, and the horse cannot move the load. Now by neutralizing the lifting tendency of the high angle trace, by putting a weight on the horse's shoulders, as in Fig. 5, he is enabled to lift the load although the trace is horizontal. In further illustration, reference may be made to Fig. 6, in which, with a trace angle

greater that in Fig. 3, the horse's weight at the collar acts through the line P W. The weight is supported at O, and, as against the resistance P 3, acts along the line P O.

Thus, with the high angle trace the lines P W and P O approach each other, and the trace line P 3 approaches the position in which a force applied at the end of a lever acts to the greatest advantage, namely, normal to or at right angles to the lever. These diagrams may be sufficient to show the importance of a low angle trace and a short trace. Of the value of a low attachment there can be no doubt, but, as already stated, it is desirable to have the action of a high attachment for level and good roads, so that the pull on

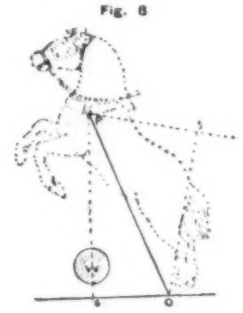
Fig. 5



the collar may always be the least, and even in some cases so that the pull takes some weight off the horse's feet.

When Mr. Brigg first brought out an attachment for automatically effecting this, he attached to the fore carriage of any four-wheeled vehicle an apparatus as shown in side elevation in Fig. 7. Here the shafts, instead of being pivoted at B, are so mounted that their point of rotation is carried down to C. The traces T are connected to hooks on a cross bar at E, the cross bar being supported by end links which are pivoted at F. The traces pull against a cross-leaf spring connected with E, but for explanatory purposes we here show in the diagram a spiral spring at S. Now it will be seen that the traces pull through the spring, and so long as the road is good and level and the resistance offered by the vehicle is within the power of the spring S, the trace will pull through the line T S, and the shafts will rest as in the ordinary way, supported by the harness at G. As soon, however, as the vehicle enters upon a hill the pull necessary to haul the vehicle is increased, the spring S is overpowered and the link E F comes into contact with the heel of the shafts at B. Now the shafts and the pieces B C being converted into

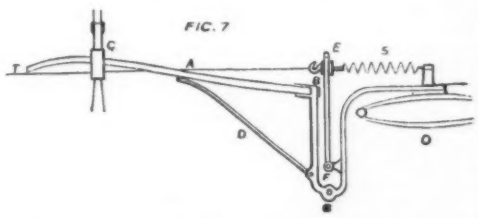
Fig. 6



rigid structures by the stay D, the pull upon the trace and the pressure of the piece E F on the heel of the shafts at B causes a downward vertical pressure upon the saddle strap at G, and this downward pressure will be proportional to the resistance of the vehicle. Thus, instead of taking weight off the horse's fore feet when going up a hill, and when he requires it most, he has this weight returned to him; and not only this, the weight which is thus usefully given him is taken off the fore wheel and the draught of the vehicle thereby lightened.

Here we have, then, the equivalent of the actions explained with reference to Fig. 1A. The results of the application of this attachment were, it is stated, very satisfactory, but further study of the subject showed that a better result could be obtained by even more simple means. In the apparatus, Fig. 7, the pull is always that of a horizontal trace until the resistance is greater than that of the spring S, or until the bar F E actually bears against B. For the heavier pulls up to this point it is desirable that the virtual line of draught should be lowered somewhere between E and C. With the apparatus shown this could not be done, and moreover that part of the weight of the shafts

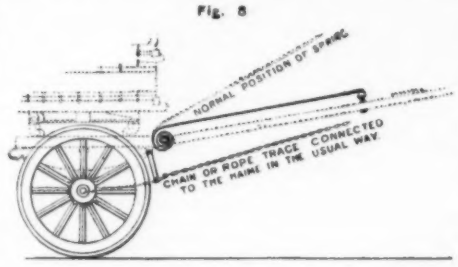
FIG. 7



which is supported at G is never lessened or removed from the horse's back, and this with the heavy shafts of many wagons is in itself sufficient to cause a considerable part of a horse's fatigue. To secure the desired end and to overcome these objections, Mr. Brigg has devised the apparatus shown by Fig. 8. This consists of a pair of springs attached by a simple clamp to the fore carriage and to the shafts. The strength of the spring is proportioned to the weight of the shafts, to the position of the point of attachment of the traces, and to the upward lift which it is desired to put upon the belly band.

The amount of this upward lift can be varied by the clamp attachment, which allows of adjustment of the position of the spring in its unloaded position. The action of this apparatus, it will be seen, is to exercise always a lifting effort upon the belly band. This, it would seem, is undesirable, as removing weight from the horse's feet, whether on level ground or on a hill, and though generally desirable on the level, it is the reverse on a hill. The result of this, however, is that a low angle of trace can be adopted with very great advantages, and a very variable virtual angle of draught is secured. To explain. In Fig. 9, suppose the line A B to represent a horizontal trace, and at the same time the pull of a horse in both direction and magnitude, and B C to represent the lift by the springs in Fig. 8. Then the virtual line of draught will be in the line B D, a very satisfactory direction when the resistance of the vehicle is comparatively

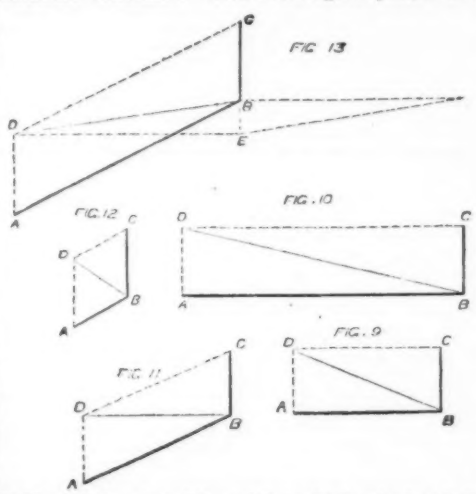
Fig. 8



small, and the horse may, therefore, advantageously get all possible relief.

When the resistance to traction increases to that shown by the length of the line A B, Fig. 10, the lift B C remains the same, but is relatively smaller, the virtual angle of draught is lowered to D B. Thus the angle of draught varies with the resistance. In each of these cases the attachment of the traces at D would have the same effect as is brought about by attachment at A and the lift B C—that is to say, then, so long as the pull is along a line A B, Figs. 9 and 10, some of the weight of the horse would be taken off the horse's feet, even when going up hill, which is undesirable. When going down hill the best limit of angle would be theoretically that which would carry the horse, and when going up hill the best angle would be that which enabled the horse to receive on his back as much of the load as should under any circumstances be put upon it.

Now, by means of the low attachment with the same pull as in Fig. 9, and the same lift B C by the springs, the virtual angle or line of draught in Fig. 11 is brought down to zero or to a horizontal line, a good line for a moderate resistance. With a still lighter pull, as at A



B, Fig. 12, the virtual line of draught is raised to D B, taking more weight off the horse's feet; but when the load becomes as heavy as represented by A B in Fig. 10, the virtual angle of draught with the low-down attachment, as at Fig. 13, is brought down below the horizontal, as at D B, and the lifting effect B C is not only neutralized, but there is a downward pressure brought to bear on the back band equal to B E. It will thus be seen that by means of this attachment the virtual angle of draught is automatically brought into correspondence with the resistance to traction.

Very numerous examples of the application of the principles underlying this question of virtual line of draught might be appealed to, as, for instance, the use in modern London coal wagons of high front wheels, and the practice with all carters of getting as much of the load on the front wheels as possible; the different ways in which navvies load their barrows when going down or going up hill, and the different angle at which men wheeling trucks put the handles on different roads. There are also other points which might be explained with regard to the attachment described, but sufficient has already been said to explain its action in the most salient respects, and to show its importance.

With this apparatus, as with other things, the proof rests with practical working, and as to this, it may be mentioned that the Great Northern and other railway companies have had vans fitted, and the effects on the horses noted for some months in widely separated towns. The experimental trials showed that the horses were able to take a greater load than before with much less fatigue, and that they increased in weight. The result is that the Great Northern company has decided to have other vans fitted.

GAS LEAKAGE.*

By CHARLES H. NETTLETON.

BY the term leakage I mean the difference between the gas registered at the station meter and the amount for which we make out gas bills, plus the quantity consumed at works, offices, etc., in other words, the unaccounted-for gas.

* Read before American Gas Light Association, New York, October, 1891.

The causes for the difference between the gas we make and the gas registered by consumer's meters are numerous, and some of them I propose to consider at length.

Temperature.—One of these causes over which we can have but little control, and to which I think but little attention has been paid, is the difference in temperature at which the gas is measured at the gas works and that at the consumer's meter. A friend of mine tested the temperature of the gas for a year, in New York city, at the station meter of the works in his charge and at the meter in his own house, and the average difference was nearly 16°. In this case the house meter was in the cellar. Allowing for meters kept in warmer places, such as factories, stores, etc., it is probably safe to say that in this latitude the difference in temperature of gas when made and when sold is not far from 10°, and as every 480 feet of gas expands or contracts about 1 foot for each increase or decrease of 1° in the thermometer, it follows that for the estimated 10° the contraction is 2 per cent., so that of our apparent loss of 5 or 10 per cent., about two parts are beyond our control.

Leaks in Mains.—The main source of loss, however, is probably leaks in mains and services.

Thanks to the energy and ability of the men who make our pipe to-day, we have, whether using cast iron, wrought iron or steel, a uniformly good pipe, in using which, with reasonable care, good joints can easily be made. The younger men in the business will never know, unless they happen to use some ancient "special," the annoyance and bad language that were produced years ago, by the spigot end of some fitting being too large for the hub of some pipe of the same nominal size, though both pipe and special, perhaps, came from the same foundry, or when, in regular hub and spigot pipe, the space for a joint was only one-eighth of an inch in width. With such pipe it was very difficult to make good joints, and consequently difficult to keep down the leakage.

I am unable to speak from personal knowledge of the use of wrought iron or steel pipe as mains, but those who have used that kind speak highly of it, particularly in connection with its freedom from leaks. The company with which I am connected have nothing but hub and spigot cast iron mains, and as they, in this section of the country, are used almost exclusively, I propose to confine my remarks to them alone. Owing to the heavy water pressure put upon all cast iron pipes at the foundry where made, the pipes when first purchased are almost certain to be without cracks or holes, and when laid, and the joints well made with either a good soft lead or Roman or Portland cement, one is reasonably sure of having a tight pipe before the ditch is filled.

In regard to material used in making joints; personally, I prefer those made of cement, on the score of much less cost and less liability to leak. A personal experience, which is no doubt familiar to many of you in your own work, will best illustrate my faith in cement joints. In a severe winter, several years ago, the frost had gone down around a six inch gas pipe on a certain street, and a large leak was reported in that neighborhood. On digging up the pipe it was found to have pulled apart three-eighths of an inch where tapped for a three-quarter inch pipe, and a cement hub and spigot joint, less than three feet away, was intact. I think the chances are that with a lead joint the latter would have drawn, and a leak started which would not have been stopped until the "smelling committee" (as named by one of our local papers) had put in its work. But either lead or cement with well driven gaskets makes a first class joint.

The filling of the ditch as far as the top of the pipe is a very important matter, and too much care cannot be taken up to that point. Crooked rammers should be used to pack the dirt firmly and solidly under the pipe, so as to give it as solid a foundation as possible. But in doing this, care is needed, particularly with small pipes, to see that the dirt is not rammed too vigorously, thus raising the pipe out of line and making the first start toward leaky joints. I desire to emphasize this point, as I believe as much, or more, depends on the way the ditch is filled, as on the way the joints are made. Another personal experience may illustrate this.

About twelve years ago, when knowledge seemed to be much larger in quantity with the speaker than at the present time, I had occasion to lay about 8,000 feet of 8-inch pipe. It was rushed through, and the cost per foot was satisfactorily small, the gas was turned on, and tested by means of a meter and valve. To my surprise and mortification the gas was going through the meter rapidly, although not a consumer was on the main. Some of the leaks were soon found and stopped, but the pipe could not be made satisfactorily tight at once. Afterward I found out that in the hurry of getting in so many lengths of pipe per day, in certain sections the dirt had not been properly rammed under the pipe. For nearly three years after it was laid it was a source of great annoyance and expense, but finally, with the ramming that each length received when a leak was repaired, the trouble disappeared and to-day it is as tight as any other length of main under my control. But while the trouble lasted I believe it is no exaggeration to say more than 500 leaks were repaired on that line of pipe. Since that time my attention in laying pipe has been given principally to packing the dirt under and around the pipe.

Kind of Soil.—The quantity of leakage depends to a considerable extent on the character of the soil surrounding the pipes. Given a sandy or gravel soil, and the passage of the gas from the pipe through a hole or a cracked joint is hindered very little by the surrounding dirt; loam lessens the leak materially, and stiff wet clay makes the pipes tight, holes and cracks to the contrary notwithstanding.

In a certain city in which the gas pipes are surrounded by mud, through which the gas cannot be forced by the ordinary pressure, I was told that the leakage was absolutely nothing except the gas lost in making connections with services, laying new mains, etc.

In this connection it may not be out of place to describe the method followed by the speaker in searching for leaks. The gang is made up of a foreman and either eight or ten men. The foreman from his book containing the location of pipes, lays out the line of pipe,

indicating same in any convenient manner. Along this line, when on unpaved streets, a man makes holes every 6 or 8 feet through the crust of the road with some light, pointed iron bar, generally a piece of 1-inch pipe with a steel point at on end.

Following him come six or eight men in couples, each with an 8-pound striking hammer, and each couple with a steel bar about 3 feet 6 inches long, having one end drawn out to a long, sharp, tapering point. In the shallow holes made by the man in advance, these steel bars are driven, each bar being struck by two hammers. When driven from 2 to 3 feet, the distance varying with the known depth of the pipe, the bar is hammered sideways, and then is easily withdrawn by hand. The two men take their bar and go forward immediately to drive another hole.

Following these is another man whose sole business is to smell at the openings made by the bars, and then fill in the same with loose dirt, reporting all leaks to the foreman.

On paved streets, the same bar is used for a short distance to separate the paving blocks, and then a smaller bar is driven down to the main. So much difficulty was found, however, in withdrawing the bars on paved streets, that to save time a tool was made which, while crude, works well. A heavy bar with jaws on one end is used as a lever, a piece of hard wood cut on its edge into steps, the latter shod with iron plates, is used as a fulcrum, and the bar pried out. This simple device nearly doubled the amount of work that could be done on paved streets with a given amount of labor, as compared with withdrawing the bars by hand.

The above system is the result of many experiments through a series of years, and while it may not answer in all places, yet with the soil in my neighborhood, which is largely sand and gravel, it works very well.

Services.—With leaks in services, I have had very little experience; but I am told that in older companies than mine, and in those where the soil rusts wrought iron quickly, this is a large source of loss.

It is said that this destruction can be prevented by coating the pipe with one or more preparations, but of that I cannot speak of my own knowledge. Certainly, if troubled from this source, I would try to see that the services were so coated that little or no rust would form.

Consumers' Meters.—Another cause of unaccounted-for gas is the errors in consumers' meters, for which I think the only remedy is periodical testing. If a company does not test its meters for years, some of them are bound to get out of order, the bellows gradually lose their oil, do not expand to their full capacity, and the meters run fast, or the bellows are cracked, the valves or their seats wear unevenly, and the meter runs slow.

The fast meters, when they become fast enough, are sure to be heard from, by reason of complaints from consumers, are brought in, tested, and correct meters substituted; but the slow meters are rarely heard from, generally not until they fail entirely to register. In this way, and for these reasons, a company failing to test its meters will in time have a large majority running slow; and I am confident, after testing all my meters a number of times, and knowing how many run fast and how many run slow, even when repaired every three or four years, that it is only a question of a few years before 7 per cent., or even more, of all gas sent out would become "unaccounted for" by reason of slow consumers' meters.

This is one reason, but not the only one, why it pays to tests meters periodically.

Station Meters.—Another cause of loss is an incorrect station meter. How general this is I am unable to say, but more than once when hearing some wonderful tale of big yields per pound I have wondered if the station meter on which these results were based was correct. I have heard it stated that very large yields and very large leakage were quite apt to go together. But in this matter, as in many others, it is very easy to deceive one's self, and tests should be made occasionally to demonstrate the fact that the meter is approximately correct.

The following table has been prepared with care, and gives the results obtained at the works in my charge for the past 10 years:

Year Ending.	Gas Sent Out.	Unaccounted For.	Per Cent.	Miles of Pipes, Approximate.	Sent Out per Mile per Year.	Lost per Mile per Year.	Total Cost of Searching & Stopping Leaks.	Cost per Mile per Year.	Yield per lb. of Coal.
Apr. 1, '82.....	20,503,040	1,879,082	9·1	9·4	2,181,174	199,902	$862 23	$91 72	4·72
" '83.....	24,331,210	2,007,518	8·2	10·6	2,295,397	189,388	273 21	25 77	4·90
" '84.....	27,770,260	2,659,308	9·5	11·8	2,353 412	225,365	285 64	24 21	4·87
" '85.....	26,471,990	2,216,838	8·3	12·2	2,169,835	181,708	481 20	39 36	4·93
" '86.....	28,332,044	1,496,123	5·3	14·3	1,981,262	104,624	395 63	27 66	4·92
" '87.....	30,107,386	1,539,296	5·1	14·8	2,034,350	104,006	609 79	41 20	4·74
" '88.....	33,268,912	1,533,448	4·6	15·3	2,174,439	100,225	22 74	1 48	4 91
" '89.....	34,851,118	1,859,938	5·3	15·8	2,205,767	117,718	531 04	33 61	4·89
" '90	38.910,268	1,679,948	4·3	16·7	2,329,956	100,595	243 42	14 57	4·85
" '91	43,001,890	1,154,021	2·7	16·9	2,545,490	68,285	370 61	21 93	4·77

The first column is the gas sent out for the several years, as stated.

The second column, the unaccounted-for gas expressed in feet.

The third column, the unaccounted-for gas expressed in percentage of the total send-out.

The fourth column, the miles of pipe. I regret to say that the figures for the first few years are not absolutely accurate. The errors, however, I believe to be slight. The figures for the last four years are correct.

The fifth column, gas sent out per mile of pipe per year.

The sixth column, the loss per mile of pipe per year. This probably expresses leakage in the fairest way possible, for the purpose of comparison with other works; and yet given a works with a consumption of 10,000,000 per mile, and the loss due to difference in temperature at which gas is measured at works, and in consumers' houses, would probably be nearly 200,000 feet per mile. For the average sized works, however, under 100,000,000 per year, and sending out between 1 and 1½ and 3 millions per mile of pipe per year, I suggest that no fairer basis of comparison can be made than the feet lost per mile per year.

It was suggested a few years since that the size of pipe ought to be considered; that on a 12-inch pipe the chances of a leak were just double that on a 6-inch, owing to the greater area of pipe and joint. But all smaller works will average about the same sized pipes, and to figure everything to a basis of say 4 inch pipe, is a refinement that, in my judgment, is uncalled for. I am quite well satisfied that for small works 100,000 to 150,000 feet per mile per year should be considered a reasonable amount of leakage, and unless the circumstances were exceptional, a manager should not rest satisfied until that figure was reached.

Seventh and eighth columns give total cost and cost per mile respectively of searching for and stopping leaks. These columns are added to add general interest to the table, and in the hope that the discussion will bring out the fact that the costs stated are above or below the average cost in other places.

I desire to call your attention to the fact that in the year ending April 1st, 1888, but $22 was charged to leakage, but in the year following, quite a large amount was spent, and yet the leakage increased, showing the lack of attention in the previous year.

The ninth column is added so that it cannot be suggested that if the yield per pound of coal had been given the table might have assumed a different appearance. It is but fair to state that these yields are reached after adding 2 per cent. to the weight of coal carbonized. Your attention is called to the lower yield for year ending April 1st, 1891, and the small leakage in the same year. I think it is entirely probable that if the yield for the last year had been larger, that the unaccounted-for gas would not have been so small as reported.

In closing this paper I venture the opinion that, like many lines of work, it requires only patience and perseverance to make a success with the leakage problem.

Regular attention, the same we give to our manufacturing operations, through a series of years, will certainly bring the desired result. But when once reduced it will not do to assume that the leakage will remain small; the laws of nature are constantly working in a way that must produce leaks sooner or later, and if no attention be paid to mains for two or three years the leakage will surely increase, no matter how small at the commencement.

I heard one of the best known and most successful lawyers of this country say, that the conditions of success in his profession were a good stomach, a willingness to work, and a very moderate amount of brains. However much one may be inclined to take the remark, *cum grano salis*, as applied to the legal profession, there can be no question as to its truth when applied to successful work on leakage.

A good stomach—health to attend to the work, and strength to do it.

A willingness to work—industry and perseverance, a determination to reach the goal you have set for yourself, if work will accomplish it.

A moderate amount of brains—I have yet to discover the need of any considerable ability in trying to reduce leakage. We are all, the brightest man and the dullest, on about the same level when it comes to the treatment of this question.

Work, and work alone, is nearly all that is required. "Eternal vigilance is the price of liberty." Everlasting effort the price of small leakage.

BRONZING.

MR. FREDERICK BUEHRING, a practical writer of considerable experience, gives the following useful advice upon the subject of bronzing:

The printing of an underground or foundation color for bronzing is generally regarded by printers as a very simple process, requiring less experience and care than any other printing; they find a reasonable excuse therein that all ink will be covered with bronze, therefore they think it will make no difference what color is printed under the bronze or in what condition it is; but in this they are mistaken. Printing the foundation color for bronzing requires just as much experience as and even more than any other printing. Printing on a regular book or writing paper of an underground for bronzing is not so very difficult as on the various enameled papers, but there are some points connected with it that require attention. There are three facts which have to be observed under all circumstances: First, that we want solid bronzing; second, that we want to show the bronze in its natural clean or pure appearence; and, third, that we want the highest gloss on it. To obtain a perfect solid bronzing, it is necessary that the ink should be in a condition to print solid and to hold the bronze so that it cannot be dusted off when the impression is dry. To obtain the bronze in its natural color it is absolutely necessary to print a foundation color which is in harmony with the color of the bronze itself. To obtain the highest gloss it is necessary that the impression should be printed smoothly, solidly, and with no more ink upon the rollers than is absolutely necessary. Now, how shall we attain all that is required? Of course, we speak first only of bronzing on well-sized book or writing paper.

For an underground for gold bronze there is a color in the market that can be bought in any lithographers' or printers' supply house under the name of gold size. This, mixed with No. 2 varnish for reducing, is perfectly adapted to the purpose; but large establishments, which have their own grinding mills and want to grind the color themselves, may take two parts of burnt sienna and one part of chrome yellow, ground with No. 3 varnish, all in a very stiff condition, and mixed afterward to the right consisteney for printing with No. 2 varnish. For silver bronze this size would not do, as the color has too yellowish an appearance, which destroys the original silver color, and this should not only be avoided, but the color improved as well. The so-called silver bronzes are a composition metal, and are far from having a silver-like appearance. Therefore use twenty parts heavy white and one part of milori blue, ground as above with No. 3 varnish and mixed with No. 2 varnish. For copper and crimson bronze use pure sienna, with a trifle of red Vienna lake, ground and mixed as above. For nickel or genuine silver bronze use only heavy white, ground and mixed as above.

The foregoing will be sufficient for printing on book or writing paper, but on enameled or glazed papers there are sometimes many difficulties arising from the poor quality of the paper. Enameled paper is manufactured in four different grades: First, with a glossy appearance (glazed paper); second with a lower gloss (gloss paper); third, with a trifle of a gloss (half glazed paper); and, fourth, without any gloss and with only a smooth and dull enameled coating (plated paper). The color for the glazed paper must be entirely different from that for enameled paper, thus: The glazed paper with its very glossy appearance has a hard gloss surface and requires very little ink. Only No. 3 varnish should be in the ink, and a little copal varnish should be mixed with it, as the ink remains on the surface without soaking into it; the lightest touching will rub the ink off and spoil the work; copal varnish prevents this. Paper with a lower gloss requires the same as above, but less copal varnish. Half glazed paper should be printed with No. 2 varnish in the ink; ink for enameled paper without any gloss should be mixed with No. 3 varnish. In cold winter days No. 2 varnish would also answer, but no thinner varnish should be mixed with the ink at all, as the thin varnish soaks into the paper in a few seconds and no varnish will remain on the surface to hold the bronze. On the highest glazed steel blue paper only No. 4 varnish should be used in warm summer days and No. 3 varnish in the winter.

All these directions will apply if the paper is in a good state and fit for printing; but, as has already been said many times in regard to enameled papers, not all papers have a good coating of enamel to stand the manipulations above mentioned, and when the paper is poor it will peel off through the adhesiveness of the ink and the stiff varnishes, and here is where the printer gets into difficulties. Strong ink should be used, otherwise the bronze will not stick; but strong varnish makes the poor paper peel off and the impressions are spoiled thereby. Mixing thin and stiff varnishes would not answer the purpose, any more than the mixing of a thin and a stiffer varnish would make a medium varnish, as many printers think. One will always have a mixed ink with thin and a stiff varnish, and the result is the same; the thin varnish will soak into the paper and the stiff varnish will make the paper peel off, and a medium varnish will not hold the bronze on the impression. Printers have experimented in many different ways without good results. Of course, the fault was with the paper, but this does not alter the case. The paper, poor as it was, had to be printed. Some printers who could not control the adhesion of the bronze and the peeling off of the paper resorted to mixing tallow in ink with stiff varnish, thinking this would help. They calculated that the stiff varnish would hold the bronze and the tallow make the ink soft enough, so that the paper would not peel off; but they failed, as tallow has the quality of keeping the ink fresh for all time, so that the bronze can be wiped off again and will never dry properly. Now, how to overcome this difficulty as well as possible. The first thing, of course, is always to keep stiff varnish in the color and no thin varnish whatever. Now mix as much lavender oil as necessary with the ink. This softens the ink and prevents peeling off, but use no more of it than is absolutely necessary. Begin with a trifle and add more gradually until you see that the paper does not peel off any more. Lavender oil is better than tallow, as it softens the ink more, but evaporates again, and therefore, the ink will dry as quickly as without it. But here comes another question: If the work on the stone is very fine and close, too much lavender oil would spread out the fine lines and make the work look smutty and indistinct. If there is fine line work only on the stone, the paper would not peel off so easily and it could be printed without lavender oil. A slow speed on the steam press would overcome the difficulty in that case; but very often there are solids and fine work together on the stone, and here we have to use other means. Take two parts of No. 2 varnish, two parts of Venetian turpentine, and one part of yellow beeswax; melt these and mix them thoroughly with the ink. This, preserved in a covered tin box, will keep good for many years and will never get a skin on top or lose anything of its good qualities. An enameled paper which has not enough coating on and where the fiber of the paper shows through the printing should not be used at all.

The use of magnesia powder for rubbing over the tints of colors already printed is obsolete and does not answer the purpose, neither does the soapstone occasionally used as a substitute. Instead, mix your colors or tints with any gloss varnish to be obtained in lithographic supply houses. They will then dry quickly, offer a smooth surface, and thereby prevent the bronze from sticking.

Another method, which will answer the same purpose and at the same time involves the saving of at least one printing where several colors are to be used, is the following:

The most desirable paper for this process is the enameled, but a well calendered and sized book paper will answer when the printing ink is mixed accordingly.

Suppose that a show card, label, or anything similar is to be printed in seven colors, say silver, gold, yellow, red, blue, black, and flesh color. (It is not meant that only these colors and no others can be used.

but these are given as an example, to make it clear and explicit.) When these seven colors are to be used, they can be done in five printings. The artist finishes the yellow, red, blue, flesh, and black plates in the usual way, but before etching he adds the gold plate to both the blue and red original plates. No matter if this comes in contact with the other work; remember that the blue and gold are to be done at one printing and also red and gold. Add to the original yellow and flesh color drawings the same work that would be necessary for the silver printing, for the same manipulations have to be made as with the red and blue and gold plates. Leave the black as originally drawn. Print the yellow first, in the usual way, and let the sheet get perfectly dry, the time for doing which will very according to the ink and paper used. Now print the flesh color, mixed in winter mostly with No. 2 varnish; in summer mixed wiih No. 3 and 0. Let the impression lie, according to the paper, from one to five hours, and then run them, for the silver bronzing, through the bronzing machine, or bronze them by hand when there is no machine. You will now find that where the flesh color is applied to the clean paper the printing is dry and will refuse to take the bronze, and where the flesh color is printed over the yellow, the bronze will stick solid, even if done on the second day. It is only required that the bronzing shall be done at the right time; but this is not a matter requiring so much attention as one might suppose. As in all printing, it requires only ordinary care. Now the impressions have to be dusted off in the usual way, and then the third printing should be the blue. Let the ink dry again, and then print the red. The same care and manipulations apply with the silver. After the gold is dusted print the black.

This is the full process, given so plainly that every artist and printer ought to understand it. The advantages are as follows: Two printings are saved, and the customer may be charged with the full seven printings, as this is an advantage to the lithographer through special knowledge, having nothing to do with one's obligations toward the customer. When you take into consideration that bronze is desired in many classes of litographic work—that there shall be gold or silver seen on it, as the customer says—and when you can do it, as now, without incurring any extra expense, it should be easy to understand that this is an advantage which ought not be undervalued, apart from the fact that bronze printing is generally charged the price of two printings.—*The Printers' Register.*

ART IN MODERN CARRIAGES.

FEW examples of the mechanical work accomplished by American artisans furnish so admirable an illustration of the rapid progress made of recent years in the mechanical arts as the fashionable carriage of the present day. In the last decade have been achieved more improvements calculated to secure comfort and ease and elegance in equipages than was attained before in all the 600 years that carriage building of one kind or another has been going on. The carriage of to-day is a work of art, and had anything like them been known to the riders of earlier days, history would not have had to record that the eleventh king of France, surnamed Philip the Fair, issued an ordinance prohibiting the wives of the citizens of the realm from riding in carriages. This was an eminently unfair thing for the king to do, anyhow, and the women folks would have made such a hubbub over it, had the carriages been worth making a fuss over, that their husbands, for the sake of peace, would have been forced to make the king reconsider his edict or move out of the palace to give place to a more considerate monarch.

The rich men and women of to-day certainly ride about in more elegant equipages than did the kings and queens of half a century ago, and even royalty itself cannot to-day secure coaches that are any better made or more comfortable, though they may be gaudier and possess more of pomp in attendance and ceremonial, than the rich private citizen commands. It is an odd thing that multitudinous as are the fashionable equipages that crowd the streets, not one person in a thousand has anything but the most rudimentary knowledge of the way that the splendid things are built; or of the time, patience, and artistic training that are expended in the making of them. Even men of means whistle sometimes when they hear the price of the best carriages in the market, and are staggered to learn that many houses are built and furnished quicker than a first-class carriage can be made. It is possible to build a good carriage in a month, but one that will rank as the very best that workmen can put together cannot be made in less than four months, and very often where the vehicle is made to order six months is expended in completing it. An artist or a sculptor furnishes no more interesting study to those fond of watching skilled hands at work than the various artisans in a perfectly equipped carriage factory.

An artist at work with pencil and chalk, by the way, was the first spectacle that was presented the other day to the attention of a visitor who was anxious to study the details of the work of building a first-class closed carriage. The artist in question was the designer, a high-salaried employe, with an abundance of technical knowledge and plenty of originality of idea. He had spent several days scribbling with a lead pencil on odd bits of paper. These bits of paper were covered with rough sketches of springs and wheels and doors and things, and lots of figuring. He was developing a new-fangled fashion for a closed carriage for the spring of 1892. He had at last struck something that pleased the manufacturer, and this had been reduced to a small scale drawing upon the page of an ordinary memorandum book. There were several of these scale drawings corresponding to the different parts of the carriage, with the various measurements. After completing these the artist had tackled the work of making the full working drawings, and he was busy on the last one when the visitor was ushered into his study. These drawings were made the full size of the carriage intended to be made. They were tacked to a series of blackboards about fifteen feet long and ten feet high, which swung on hinges like so many doors. These drawings are kept for use in every case until the fashion changes again. Each carriage made goes through the same process in the building.

The work of building is divided into four branches, instrusted to four departments, each with a distinct foreman and a group of workmen. In one department is assigned the work of building the body of the carriage. Another foreman builds the running gear, still another looks after the making of the wheels, and then the different parts are turned over to the blacksmith to put together.

What strikes one unfamiliar with the work as singular is, that the men in none of these departments, save the blacksmithing shops, know anything of what the completed carriage is to be. The men who make the body are ignorant of what kind of wheels and springs it is going to rest on, and the wheelwrights haven't the slightest idea of what the body or the axles and springs are to be like. All that the men in any particular department have to do is to build the part intrusted to them according to the designer's drawing, and they aren't expected to bother their heads about the rest. But all this knowledge is in the possession of the factory superintendent, and he keeps what is called a "daily record" book, which, when the job is finished, gives a complete history of every stroke of work done on the carriage. When the different parts are ready for the blacksmith, he puts the carriage together to see that the several parts fit perfectly before the vehicle is painted. In a first-class carriage all the parts must fit together exactly without requiring any other exertion than the lifting or sliding of them into place. They must fit as smoothly as a glove, or there is trouble for somebody. The daily record book will show at a glance where any blame lies, and the guilty department is called to account at once.

Every carriage made is designated by a particular number, and the various foremen have cards upon which they keep track of the work by memoranda. They have to present these cards to get material from the stock room. The system is reduced to perfection in the stock room. Not a bolt or a nut or a bit of wood can leave it without the knowledge of the stock room superintendent. His inventory of stock at the end of any particular month must balance with the inventories of the different departments. This effectual stoppage of leaks from the stock room is one of the profits of the business, and no bank has a more comprehensive or complete system than the modern factory of the highest class.

The material used in first-class vehicles never varies. The body consists of the frame and the panels, which are put together upon an iron skeleton frame. The carriage frame proper is made exclusively of thoroughly seasoned ash. The panels are made of either poplar or cherry, according to the taste of the intending purchaser. The wheels of a carriage are a detail that has made reputation and fortune for a number of first-class manufacturers. A cheap wheel is very dangerous economy. A well-made wheel has often averted serious injury in collisions on the road. The best wheels are invariably made of hickory, with elm hubs. The hickory is seasoned two years and the hub elm three years. The wood of the spokes is thoroughly examined for flaws made by worms. Where there is the slightest flaw the spoke is thrown away, for it has no business in a first-class carriage. It may break at the wrong time, and a broken spoke may mean a broken head for somebody. The elm hubs often stay for years in the seasoning room before they are used, growing better with increasing age. The thorough seasoning of the elm can readily be detected by its sweet smell. If it is the least sour it is not perfectly seasoned.

The lamp glasses and, in fact, all the glass work about the best carriages, call for the best imported French plate glass. Where it is the purchaser's desire the wheel tires are cushioned with rubber. This secures noiseless locomotion, but experts do not think very highly of the cushioned tire for carriages. The best work will not last longer than three months, and wheels thus tired retard speed and increase the strain on the horse. It changes level riding to uphill work.

When the different parts of the carriage have been completed and the carriage has been put together by the blacksmith and found to be a perfect fit, it is taken apart again and sent to the painters and upholsterers for finishing. The body, wheels, and springs are all painted. The springs, by the way, are a big item of cost in the finest carriage. There are four styles of springs in use nowadays, and from $100 to $500 will be added to the cost of the vehicle according to the choice of the spring. The simplest and least expensive of the best kind is the platform spring. The second is the elliptical, the third is the C spring, so called from its shape, and the fourth and most expensive is the combination spring, made of the C spring fitted on top of the elliptical spring. The double suspension gear, with C combination springs in front and back, secures a degree of easy riding that is the acme of comfort. A carriage thus hung cannot jolt in transit over the most uneven pavement or roughest road.

The painting of a carriage is an undertaking that requires months of time when the best work is desired. It requires nine different processes to secure perfection. The carriage frame is first "primed," or rubbed with linseed oil. The oil is allowed to soak into the wood for five days. Then a coat of raw linseed oil, containing just enough lead to color the oil, is applied, and five days after that it gets a third coat, made of oil and lead mixed in equal proportions. Five days later it is painted with a compound of oil, varnish, lead, and a little japanning. Six coats of this, which is called "rough stuff," are applied, three days being allowed to intervene between each coat. After that it is washed with a staining fluid of yellow ocher, and when this has had several days to dry the carriage is rubbed down with a piece of pumice stone, a process that gives a mirror-like gloss to the paint. The painters get at it again after this and apply three coats of "color." This color is made of lamp black and oil, and oil and ivory black. The lamp black mixture is first applied. Two days intervene between each coat. On the top of all this go four coats of "rubbing" varnish. They are applied a week apart, and each coat is rubbed down with powdered pumice stone. The paint shines like glass when all this is done, and the carriage is then ready for the upholsterer.

The upholstering must be elegantly done for the finest carriages. The upholsterer uses the best imported English broadcloth and kersey and French morocco and rich satins. It has recently become the fashion to increase the sightliness of the interior by the addition of ornamental lace work, the latter woven upon the cloth with worsted and silk. It takes ten days to upholster a carriage. There is also introduced a bell call for the driver. The bell is underneath his seat. By pressing a button the person in the carriage releases a clock spring, which works the bell hammer. It works like an electric button. The clock spring will ring the bell for a month without rewinding. The timepieces are of American manufacture, and are made expressly for the carriages. They are stem winders and setters, in a dust-proof and water-proof glass and nickel case, with an outer case of nickel with a glass front, which prevents the watch being stolen.

The finishing touch of the carriage is the final application of varnish after the upholstering is completed. The finishing room is a room with all the doors and windows always closed. Air is admitted through ventilators in the ceiling, that are protected with fine wire screens. The hot room of a Turkish bath seems like a refrigerator compared with the temperature of this room in the summer time. The varnisher can work but a little while at a time. He says he has to escape to keep from suffocating. All this discomfort has to be endured to guard against flies and other insects and dust getting into the room.

A single fly could do $50 worth of damage in a jiffy. If he settled upon the fresh varnish the work would be spoiled and would have to be done over again if the fly wasn't detected in time. It would take a good deal of time to undo the mischief he would do by simply getting his legs caught in the fresh varnish.—*Harness.*

[Continued from SUPPLEMENT, No. 830, page 13267.]

THE DECORATIVE TREATMENT OF NATURAL FOLIAGE.*

By HUGH STANNUS.

Lecture III.

§ 20.—SELECTION.

THE whole of the Vegetable Kingdom is at Man's use for decorative purposes; and some have supposed that the fact—of being a Flower—is sufficient reason for using every one. It should be observed, however, that, though the whole of the Vegetable Kingdom is at Man's service for Food; yet he selects one part and rejects the remainder. So also he has the right to select and reject for Decorative purposes.

For the ordinary Decorative Work, the Selection will be limited, by *æsthetic* considerations. All things

FIG. 20.

in the Creation are beautiful when the mind understands sufficiently about them to be able to judge of their Fitness; that is, however, a *mental* quality which is assessed *after consideration.* In Decoration everything is judged by the eye of *sense;* and hence is felt to be right or wrong at the *first impression.* Therefore such Plants as are beautiful to the eye's first impression should be chosen.

Plants of ORDINARY GROWTH should be chosen; some Orchids, and other flowers, which appear to be *freaks of nature,* are interesting in scientific Botany; but are not useful in artistic Pattern work. If the interest of the observer be attracted by the representation of a rare or abnormal flower in the pattern; and he proceeds to examine it closely, with the attention of a Botanist; and finds the representation so inadequate, as it must necessarily be as a consequence of the technical exigencies of Pattern-work—he is disappointed and tantalized. It is therefore better to avoid odd or rare plants, and to select those which are familiar and numerous.

SIMPLE PLANTS should be chosen; those which are too intricate and minute, either in Flower or Phyllotaxis should be avoided. In judging of this, we must take our material into consideration; flowers with much detail in stamen and pistil might be possible in Embroidery, but are impracticable in Mosaic; and leaves that are much divided are easy in Printed work, but would be difficult to couch in Embroidery, and troublesome to fit in Inlaid-work.

SINGLE FLOWERS (*i. e.* those with one row of Petals) will be found most easy of treatment; and Double and Compound flowers should be avoided by the student. The Orientals have made most beautiful decoration with double flowers; but it should be remembered that they are not *beginners;* they have been Pattern-makers with flowers for centuries.

"GREENHOUSE PLANTS," as a general rule, should

* Lectures before the Society of Arts, London, 1891.

be avoided; and also "Gardeners' flowers" without exception. The Gardener aims to produce something *new;* the Artist seeks to do his best with the old. The Gardener aims to produce *double* flowers; for the Artist the simple beauty of Nature suffices. The Gardener is delighted with the abnormal growth, which shall figure, with his name, in a Botanical magazine; the Artist is baulked by these exceptional specimens; he seeks—not the portrait of *one* extraordinary individual flower, but—the general effect of a well balanced *pattern* made up of many.

MALFORMATIONS should be avoided, such things are interesting scientifically as specimens in a Botanical Museum, but are useless and troublesome artistically in Decoration. People may pay a penny each to

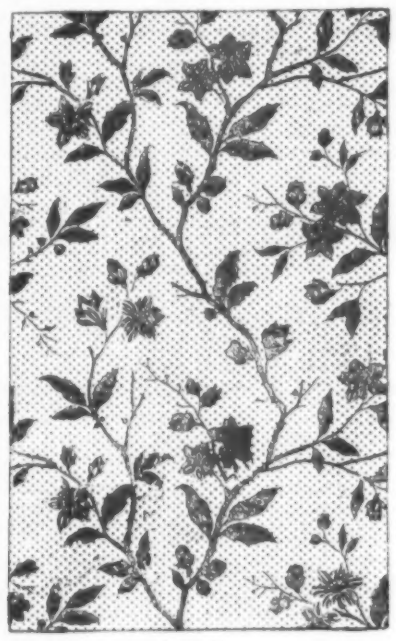


FIG. 21.

see six-legged lambs, but such objects are not introduced into Landscapes; and, for an analogous reason, freaks of nature should not be used in decoration.

PLANTS OF STRONG INDIVIDUAL CHARACTER should be avoided, as being not amenable in *Repetition*. The Lily, which appears most beautiful when, in solitary majesty, it graces the table in the Lady's Sanctum, is not always the most useful for Pattern work.

THE SO-CALLED "ORNAMENTAL FLOWERS" should be avoided. About thirty years ago, when Decorative Art was at a low ebb in England, several flowers were chosen and worked up, by some Sculptors, into designs which were published. The flowers thus used were those whose chief characteristic was *form* rather than *color*, *e. g.* the Convolvulus, Fuchsia, Ivy, Petunia, Geranium, etc. In Fig. 20, which shows one of the best of them, the shadow-lines on

FIG. 22.

the right hand side of the stems, and the shading generally, prove that it is a *relief* rather than a color treatment. The great objection is that the shapes are *too pronounced* to coalesce into the general *texture* of a pattern.

HACKNEYED FLOWERS should be avoided; there have been "runs" on the Sunflower, Vine, Ivy, Lily, Hawthorn, Convolvulus, etc.; and these might have a rest while the Student exercises his skill on others of the countless varieties around.

SYMBOLIC PLANTS which have been appropriated in connection with Religion should be avoided, unless required by the programme of the subject. A design for an Antimacassar, based on the Passion-flower, was once brought to the writer. The plant is beautiful, and suitable for decorative use in several materials; but the religious feelings of some would be hurt by that, and they should be respected. Those plants which have been assumed as Faction-badges are also subject to the same objection.

RAMIFYING PLANTS are most easy to use in connected Pattern-work (the division into branches lending itself to the diffusion of the pattern-figure over the ground); and Bulbous plants are generally useful in Powderings (*only*).

SUPPLE PLANTS whose stems bend-about, are more easily treated than those with rigid stems and branches, that do not lend themselves to the decoration of any given shape. The various Decoratable surfaces differ in shape; and the various plants differ in growth. The Student should therefore select such plants for use as have sympathy with the given shapes. In Panels of ordinary shapes, any plant may be used; but in panels of extreme shapes, the choice is limited by the characteristic manner of growth of the different plants. Thus with a tall panel (say three feet high by six inches wide), the Flag-lily and high Grasses would sympathize; while in a low panel (say six inches high by three feet long), the Water-lily and short Grasses would be more suitable.

A SUFFICIENCY OF LEAVES, to overlap the stems at intervals—in order that they may not be so *conspicuous* as in Fig. 21—is necessary. The Leaves are also useful in making masses in the composition.

FIG. 23.

LEAVES WHICH ARE BROAD in comparison with the Stems are good; when they are *narrow*, as is shown in Fig. 22—there is a want of clearness; and the pattern may have a "liney" effect. It will be remembered that *line* and *shadow* are characteristic of Artificial foliage; while in Natural foliage *mass* and *color* are necessary.

DISSIMILARITY BETWEEN THE LEAVES AND PETALS in mass-shape, edge-treatment, color or texture, is helpful; when the flowers and leaves are the same Shape or Color—there is a want of Variety and of Clearness.

§ 21.—PRELIMINARY STUDIES

The Preliminary Studies of the selected plant should be made from various points-of-view, carefully copying the method-of-growth and color, etc., not only of the flowers and leaves, but of the branching; and they should be continued until the Student can draw the plant in all its detail from memory.

The normal appearance of the plant should be given as it is seen growing in the ground under ordinary circumstances, *i. e. in perspective* and not in the severe plan, elevation and section used in the Working-drawings of an Engineer.

The Botanical details should also be carefully noted, as viewed closely and on a level with it; these are, however, scientific statements of fact, to be used in *explaining* the appearances, but not in supplanting them.

After the careful studies of detail, some Brush-studies should be made. These are not to be drawn in pencil, but quickly blotted in with a brush, at once. The Student need not in these studies attempt to match the colors of the plant. He may make them in monochrome, using any waste color which may happen to be on his palette. Persevering practice gives power of seizing the characteristic masses of the plant; and further tends to induce somewhat of that marvelous dexterity in Brush-work, which makes our Japanese brethren such consummate Craftsmen.

The Scale of the representation should be the same as in Nature. This is only a particular case of the general rule that all pattern-work should be of the *same size* as Nature. The observance of this rule will prevent the selection of unsuitable plants; and also the unsuitable treatment of suitable ones. It is well that the Spectator should be able to recognize the kind of plant which has been used; and preserving the Size conduces to this.

This rule may be made *elastic* to the extent of representing plants one-fifth larger or smaller than Nature (there is no virtue in one-fifth, but the line must be drawn somewhere). Also there may be *exceptions: e. g.* in decorating objects in the Precious metals (which by reason of their preciousness will be always of small size), and objects of Porcelain, etc. (which by reason of its perfect surface will allow of minuteness). When the representation is smaller, it should be *distinctly smaller*, say one-third or one-fourth the size of Nature.

And the further Rule about reduction in Scale should be borne in mind: That the decoration must be either all reduced to the *same scale* (*i. e.* if the flowers be ¼ full size, then everything else must be ¼ full size): or the decorative features which are of different scales must be applied in *different parts* of the scheme (*e. g.* say the smaller scale in the borders and other unimportant parts, and the larger scale in the panels, centers, and other important places), and there must be strongly-marked dividing-lines between them.

§ 22.—THE AIMS IN DESIGN.

The aims in design with natural foliage should be:
(i) Clearness in the Composition (see § 23).
(ii) Naturalness in the Treatment (see § 24).
(iii) Acknowledgment of the Prescribed Shape (see § 29).
(iv) Distribution over the given Surface (see § 30).

The Rules which conduce to these are correspondingly divided. They are given suggestively to Students: the observance of them cannot be guaranteed to produce good designs, but it will probably prevent any very bad ones.

§ 23.—CLEARNESS OF COMPOSITION.

The representation of objects by means of Drawing is assisted by the following adjuncts: (*a*) Light and shadow, (*b*) Local color of each portion, and (*c*) Aerial perspective (*i. e.*, the reduction in intensity of the color according to the distance). When any one of these three is absent, then the onus of clearness is cast with additional weight on those that remain; and when all three are absent, then the Artist must give the whole of his consideration to the Drawing, in order that the absence of the *pictorial* may be compensated by the *decorative* clearness.

In Applied art some one or more of these adjuncts is generally not available; and the Artist endeavors to produce his work—with such slight alterations in the positions and attitudes of branches, etc., as shall conduce to decorative clearness without doing violence to the natural growth.

As a GENERAL DIRECTION: the student should not attempt to represent *subtile foreshortening* with incomplete technical Appliances; he can always move the flower or leaf a little, in order that the shape may be simple and "read" clearly.

Examples of the Faults, causing want of Clearness, which are most frequently committed, are shown in Fig. 23; and the accompanying diagram, Fig. 24, shows a correction of each, for comparison. The numbers of the following paragraphs correspond to those on the former diagram.

1. THE OVERLAPPING OF FLOWERS by leaves or stems should be avoided. In looking at a plant the Spectator's glance is attracted first by the Flowers, secondly by the Leaves, and lastly by the stems. If any flower be behind a leaf, he pushes aside the leaf, or changes his position; and the Decorative treatment should do this for him. A Leaf may be permitted to overlap the lower part of a Flower; but a Stem should never do this. Fruit, when large, may be overlapped by leaves, because there is no small detail to be spoiled: and the overlapping takes away their conspicuousness (see Figs. 31 and 37, 4th lecture).

2. THE COVERING-UP OF THE GROUND by Leaves should be carefully avoided. When, with a thickly leaved plant, it is not possible to show ground all round each flower or leaf: then small portions of it should be left to show through between the leaves (compare Fig. 29 with Fig. 28, 4th lecture). It is not the *Ground* which is of importance; but that *sufficient of the shape* of the hinder leaves may be seen, so that they may be understood.

3. DOUBLE COMPLICATION should be always avoided. When all Leaves are flat, without twist or bend, and no leaf overlaps another—then the design is simple. The twisting or bending over of a leaf is a complication; the overlapping of two leaves is also a complication, and both of these should not occur in the same place. The second leaf should cross behind a simple part of the front leaf, or should be moved away to be clear, as shown in the two instances.

4. THE ENDS OF LEAVES should not be covered, if possible. The bad effect, of the several instances of this, will be apparent.

5. COINCIDENCE OF EDGES, of Leaves or other portions, should be always avoided. When the leaf appears to lie along the side of another leaf or stem—then it should be pushed away; as otherwise the equal width of the Ground interstice would suggest a stem or vein, and Ambiguity would result.

6. COINCIDENCE OF CENTER-VEINS between two petals, leaves, etc., should be always avoided, for the same reason as the former—that it attracts the attention and causes Ambiguity.

7. OVERLAPPING HALF-A-STEM should be always avoided. The overlapping feature should either be taken completely and frankly across the stem, or be pushed away clear of it.

8. TOUCHING OF LEAVES, ETC., should be avoided, when possible, and the parts should either frankly overlap, or be pushed away.

9. AMBIGUITY OF STEM is unpleasing. This may generally be avoided by pushing aside the leaf, etc.

10. COVERING THE NODES should be avoided, when possible. In many plants—the stem, after throwing a branch in one direction, turns a little in the opposite direction, for the purpose of preserving its equilibrium; and this is more pleasing in a design when the cause is apparent.

11. PROMINENCE OF STEM should be avoided, unless that is a strong characteristic of the selected plant. They should be so arranged as to be visible on examination, but not at the first glance which should be attracted rather by the Flowers or Fruit. The student should endeavor to carry leaves (often) to overlap across the stem, and flowers also (when possible), for the purpose of interrupting the lines it makes. If this be not done—then the lines would be too strong, and spoil the design.

FIG. 24

§ 24.—NATURALNESS OF TREATMENT.

Naturalness of Composition, which is the second aim, may be considered as antithetical to Artificiality, the quality which results from "Art and Man's device."

The contrast between these two qualities may be well observed on a pebbly beach. There, the pebbles are left by the receding tide distributed in confusion; but, after children have been at play, a great difference is observable. They have made "houses;" and the beach is no longer in confusion; but shows arrangement, according to some law. The pebbles are in lines, at equal distances; the lines are straight, circular, or otherwise geometrical; the lines are parallel to each other, or at right angles to each other; and everything is symmetrically disposed.

As distributed by the tide, the pebbles do not disturb the infinite *breadth* of Nature; they form a part of the *Mass* which is enriched in mottled texture by their presence. When arranged by the children, the pebbles seem to assert an *Individuality* apart from their fellows; they form *lines* which attract the eye and destroy the restful texture. This latter state is always a sign of the work of Man, and is right in its place where man congregates in towns. But when he seeks delight in Nature, and would bring some remembrance of it into his dwelling, he will avoid these disturbing qualities. Hence the necessity of the avoidance of Artificiality.

It is, of course, impossible to avoid *artifice* in making patterns; but the Pattern artist may avoid the *appearance* of it. In this effort he will ever find that the greatest Art is in concealing Art; and he should always strive toward that end, that though his work be full of thought, there shall be no trace of it, but all shall appear as if it had "grown so."

Examples of the Faults, showing Artificiality, which are most frequently committed, are shown in Fig. 23; and the accompanying diagram, Fig. 24, shows a correction for each, for comparison. The numbers of the paragraphs correspond as before.

12. ALIGNMENT OF FLOWERS should be avoided. In Diapers a certain amount of alignment is unavoidable; but this may be counteracted (see § 34.) In Fig. 23, the three flowers in a line are unpleasing. (See also fault 25 *seq.*)

13. EQUIDISTANCE should be avoided, especially between flowers.

14. AXIALITY OF FLOWERS, on stems other than their proper ones, should be always avoided. This often occurs in artificial diapers among the Persians and Chinese, but never in natural foliage.

15. SIMILARITY IN SIZE should be avoided when possible. The flower 15, and that near 12 are too nearly alike in size. It would be well to introduce another flower, either larger or smaller, near one of them.

16. SIMILARITY OR PARALLELISM IN ATTITUDE of flowers and leaves should also be avoided when possible. This may generally be corrected by pushing one of the features a little to one side.

17. RIGHT ANGLED CROSSING of Leaves or Stems should always be avoided.

18. EQUIDISTANT CROSSINGS of leaves should always be avoided; when the lengths from the intersection to the tips of leaf are equal, then one leaf should be pushed away to alter this.

19. DOUBLE INTERSECTIONS (*i. e.*, the intersection of three lines in the same point) should always be avoided, whether it be the intersection of the center veins, as in Fig. 23, or of the edges.

20. THE COMMENCEMENT OR TIP of a leaf should not coincide with an underlying or overlapping stem or other feature. The example of each of these faults will show the artificial effect of this.

21. OPPOSITION OF AXES or center veins on leaves and flowers, etc., should be always avoided. The bad effect of this in natural foliage is so obvious that it is rarely perpetrated.

22. CENTRALITY OF POSITION in flower or leaf should be always avoided. The two instances, in which the leaf is central between other features, will demonstrate this.

23. ACCIDENTAL RADIATION should be always avoided. This results from the meeting together of the leaf tips, and can always be obviated by pushing aside.

24. SYMMETRICAL BRANCHING should be avoided. This is undoubtedly one of the facts of Scientific Botany; but for *Artistic* purposes, a point of view should be chosen which avoids it. The two examples in branching and the one in the position of leaves are all corrected in Fig. 24.

25. ALIGNMENT OF EDGES in leaf or flower should be always avoided in the *inner parts* of a pattern. It has great value when used round the *outside*, against the bounding lines of a Panel or Border, in giving Parallelism (see Figs. 26, 29, and 36, 4th lecture); but when applied to the innermost leaves of a panel, it makes a *line* which cuts the panel in pieces.

26. STRAIGHT LINES in stems should be avoided when possible, especially if *horizontal* or *vertical*. In using plants which have rigid stems, this is not always practicable; but they may generally be bent or be pushed a little out of the perpendicular; and when *oblique* are not so objectionable.

27. GEOMETRICAL AND CONTINUOUS CURVES in the stems should be avoided, when possible, and fragmentary indeterminate ones should be sought for and used (see Fig. 20 for fault.)

28. PARALLELISM BETWEEN STEMS should be always avoided. This is a common fault; and the artificiality is very damaging to the naturalness of a design.

29. INTERLACEMENT OF STEMS should be avoided. This does not seem out-of-place when recurring regularly in Byzantine or Skandinavian work; but an isolated instance in Natural foliage will give an Artificial air which is incongruous. Sometimes the Roots or starting of the stems are interlaced in an artificial manner. These parts cannot be made too simple; the torn bark is the most natural.

§ 25.—EDUCATED NATURE.

These methods of Selection and Arrangement, which are termed "educating" the natural foliage, do not necessarily demand either the Realistic or the Conventional methods of representing the plant; but may be used with either. Thus there may be an arrangement of Flowers "*realistically*" represented, which is educated so that it may pleasantly and efficiently decorate a space; and the same arrangement might also be *conventionally* represented, and equally be good decoration.

§ 26.—NOTE ON ANALOGY.

It will probably have been observed that these suggested Rules are analogous to the little acts of selection and adjustment which the landscape-painter (*unconsciously*) and the historical painter (*consciously*) practice.

The foregoing Suggestions are all *negative*. No positive rule is necessary in the treatment of Nature, if the Student will use and *not abuse* the riches that lie at his feet. These rules are all to the end that the design be kept clear (*i. e.* simple and easy to comprehend) and natural (*i. e.* that he shall withhold all artificial interferences of his own ideas) and shall give Nature a chance. He cannot, by taking thought, improve upon it; he should see that he does not, by extraneous treatment, spoil its beauty.

IMPROVED ALTERNATING CURRENT DYNAMO.

THE alternator we illustrate herewith has been constructed by Mr. Rankin Kennedy, of Glasgow, and belongs to that class in which both the exciting and the generating coils are fixed, the revolving part consisting of laminated iron inductors. Machines of this class have been made by many inventors, such as R. Knight, Wheatstone, Henley, and lately by Kingdon on a large scale. Such dynamos have also been designed by Mordey & Forbes.

The points of novelty in this new machine are chiefly

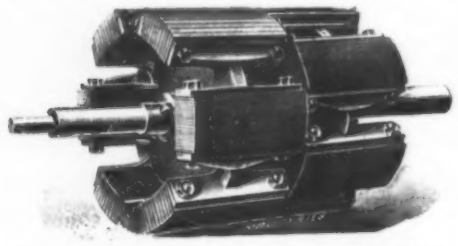


FIG. 1.—GENERAL VIEW OF INDUCTORS.

the arrangement of the coils of wire and the construction of the magnetic circuits, whereby only two exciting coils and two generating coils are required, however large it may be made, and however great may be the pressure and frequency of the alternating current required. The machine very much resembles a transformer in its parts, and is about as simple in construction. The iron field magnet portions surround the copper coils, which are simple rings of insulated wires; the inductors are carried on gun metal wheels, and in revolving alternately open and close the magnetic circuit round the copper coils, thus inducing current in them. There is no reversal of magnetism in any part of the operation of the machine, only a simple rising and falling of the magnetic flow without reversal. The iron is made of very ample sections, so that the induction is never high, and never falls to zero. The excitation is constant, but the induction varies with the position of the inductors. In a machine recently built, and which is illustrated in Figs. 1, 2, 3, and 4, the e. m. f. was 8 volts per turn of generating coil, the speed 750, the excitation 15 amperes under 35 volts, the inductors 6 on each side, the total pressure was 2,400 volts, with 300 turns of wire on generating coil the output was 24,000 watts.

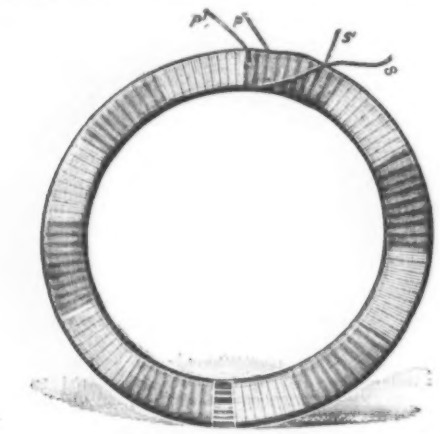


FIG. 2.—PAIR OF COILS.

Fig. 3 is a general view of the machine, Fig. 1 is a view of the inductors on the shaft, Fig. 2 is a view of one pair of coils, and Fig. 4 shows the construction of

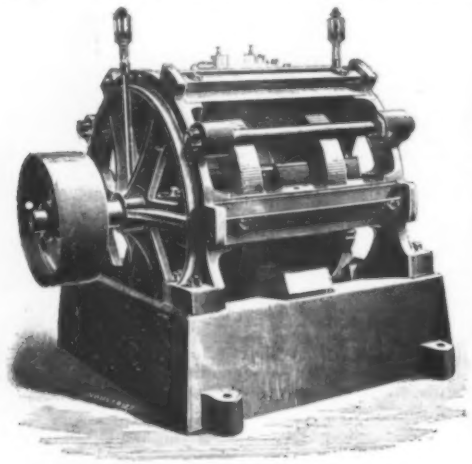


FIG. 3.—IMPROVED ALTERNATOR.

one of the field magnet blocks. There are two pairs of coils in the machine, and two sets of inductors placed as shown in Fig. 1. The generating coil is wound first and insulated, then the exciting coil is wound over that, and the whole is insulated and fixed in the machine in the recesses formed in the field blocks, as shown in Fig. 4. By using two pairs of coils and two sets of inductors, and exciting the coils so that the field blocks are magnetized with a pole in the middle and similar poles at each end, as marked in Fig. 4, when the two exciting coils are in "series" with each other, any inductive effects on the one exciting coil are exactly and entirely neutralized by those effects on the other exciting coil. The two generating coils can be coupled either in series or in parallel, but the exciting coils must always be in series. This machine is exceedingly simple and inexpensive to build, and there is no difficulty with insulation or in constructing them for any pressure or frequency required. In large dynamos there are four pairs of coils and four sets of inductors.

In the machine illustrated the inductors are 21 in. diameter, the coils being 21¼ in. inside diameter; the electromotive force of the generating coil is about 1·35 volts per foot working at very moderate inductions

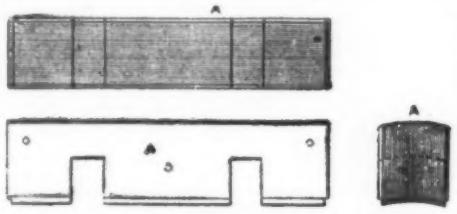


FIG. 4.—FIELD MAGNET BLOCK.

and at moderate speed, and this can be safely raised to 2 volts per foot. For low pressure alternating currents this machine is equally applicable.

In central stations for electric lighting supply in districts where the stations are surrounded by consumers, it is advisable to use low pressure dynamos, so as to supply the immediately surrounding neighborhood direct from the dynamos, and to supply the distant consumers through step-up transformers. As a motor this machine works well, but has to be brought up to synchronism, like all other synchronizing alternators.

A machine with inductors 4 ft. in diameter gives an output of 150,000 watts (100 volts 1,500 amperes) at a speed a little over 200 revolutions per minute. This is suitable for low pressure distribution near the station, and high pressure at a distance by means of step-up transformers.

In Fig. 2 P¹ P are terminals of the exciting coil, S¹ S are the terminals of the generating coils. By using only two coils in large, slow speed machines it is expected that the complications hitherto met with in large machines are obviated, most of them requiring two generating coils for each period per revolution. An ordinary machine making one revolution per second would require 200 coils to give a frequency of 100 per second. The machines are specially designed for continuous running at central generating stations. —*Industries.*

EARLY HISTORY OF THE DISCOVERY AND USE OF TIN.

A VERY interesting work is that of Philip William Flower, written and published in England, and entitled "A History of the Trade in Tin; a Short Description of Tin Mining and Metallurgy; a History of the Origin and Progress of the Tin Plate Trade, and a Description of the Ancient and Modern Processes of Manufacturing Tin Plates." It is a somewhat rare work in this country, says the Boston *Herald*.

In the search for information through the archives of the world as to the origin and first employment of tin, Mr. Flower tells us that shortly after the description of the flood will be found a reference to Tubal Cain, "an instructor of every artificer in brass." The notice in Genesis thus fixes the discovery and use of tin and copper, according to the Bible, at between 4003 and 1635 years before the Christian era.

And not only were the existence and use of these metals known, but the art of converting them was soon far advanced, for we find in the Book of Kings, written 1015 B. C., "King Solomon sent and fetched Hiram out of Tyre. He was a widow's son of the tribe of Naphtali, and his father was a man of Tyre, a worker in brass, and he was filled with wisdom and understanding and cunning to work all works in brass."

Any one doubting the nature of this metal can be reassured by reference to the chapter which follows, giving in detail a most elaborate schedule of the pillars, the chapiters, the baths, the lavers, the pots, the shovels, and the basins, some of cast and some of wrought bright brass, which Hiram the artificer prepared for the temple of King Solomon.

Further ample evidence as to the early use of tin and brass is to be found in the Iliad of Homer, written, as it is believed, between the years 962 and 915 B. C.

We find, then, that brass—and consequently tin—existed in Tyre, the great seaport town of the Phenicians, on the coast of Syria, about 1000 B. C. They are frequently referred to in all works relating to tin or to Cornwall.

The Phenicians were merchants, and carried on an important trade from the ports of Tyre and Sidon. These cities rivaled each other in magnitude, fame and antiquity. The Tyrians excelled all other nations in the manufacture of a purple dye, said to have been extracted from a shellfish found on their coast.

It is now well known that tin dissolved in muriatic acid produces a brilliant purple dye, and that tin dissolved in nitric acid will produce a scarlet dye. It is not unreasonable, therefore, to suppose that the use of tin in dyeing had much to do in the production of the Tyrian purple of the Phenicians.

It is impossible to fix the date at which the export trade in tin was commenced from the British Islands, but it is certain that it existed and was controlled by the Phenicians when Herodotus wrote his history, 450 B. C.

Herodotus refers to the Cassiterides (the Scilly Islands) as the places whence they were then obtaining their supplies; but neither he nor any other historian has left us any information as to when that trade commenced. The Phenicians called this land of tin "Baratanac," and Bochart and other historians attribute the very origin of the name of Britain to this work.

After the Phenicians the trade in tin with the Cassiterides was taken up by the Greeks sailing out of Marseilles, the city of Massila, which was built by a colony of Greeks 600 B. C. The Phenicians probably sailed straight across from their colony of Gades or Cadiz, and returned direct to that port with their valuable cargoes.

The Greeks, however, appear to have been accustomed to coast up the English channel, and crossing over from Kent to France, the tin was conveyed overland on horseback in thirty days to the mouth of the River Rhone.

The Romans, who had always been large purchasers of tin, were the next to follow the Phenicians and Greeks.

The following anecdote is derived from Strabo, who also tells of the conquest of Britain by Cæsar: "Formerly," he says, "the Phenicians alone carried on this traffic (in tin) from Gades, concealing the passage from every one, and when the Romans followed a certain shipmaster, that they also might find the market, the shipmaster of jealousy purposely ran his vessel upon a shoal, leading on those who followed him into the same destructive disaster. He himself escaped by means of a fragment of the ship, and received from the state the value of the cargo he had lost. The Romans nevertheless, by frequent efforts, discovered the passage."

As soon as the Romans made a conquest of Britain they formed in the tin province camps and roads, still visible, and left behind them vases, urns, sepulchers, and money that exhibit daily proofs of their having been a stationary people in these parts, and that Damnonium extended even to the Polerian promontory or the Land's End, limited by the western parts of Somersetshire.

The Romans, as is well known, occupied Britain from B. C. 55 to A. D. 409, or 464 years, during which period the Cornish tin mines were largely worked by the ancient Britons, possibly for their own advantage, but more probably as serfs, and in A. D. 409 the Romans had to give way to the Saxons.

During the Saxon dominion (from 410 to 1066) the mines were almost entirely neglected, frequent intestine commotions, and the subsequent wars with the Danes, allowing no time for such innocent and peaceful pursuits. In the year 1066 the Saxons in their turn were pushed aside by the Normans, and subsequently the tin mines in Cornwall were again vigorously developed.

The Norman sovereigns derived immense revenues from the export of this metal, and, in the year 1198, when the country was almost ruined by the crusades, Richard Cœur de Leon, then abroad, placed the management of the mines in the hands of the Archbishop of Canterbury, who, from this and other sources, was enabled to collect and remit to his employer a sum of money exceeding £1,000,000 sterling.

In the reign of King John (1198-1216) the produce was so inconsiderable that the rent of the tin farm amounted to no more than 100 marks. At this time the Jews were sole managers, if not proprietors, of the mines.

The right of working the mines was then wholly possessed by the king, who, being sensible of the languishing state of the manufacture, bestowed some valuable privileges on the country by relieving it from the operation of the arbitrary forest laws, and granting a charter to the tinners.

Tin mines were known to exist in Spain, but the constant invasions of the Moors caused the mines to be abandoned or neglected.

In the year 1240 tin was discovered in the mountains of Bohemia by a Cornish tin man who had been banished from his native country either on account of his religion or because he had committed murder. Further discoveries followed at Altenburg, in Saxony, 1458, and in Barbary, 1640.

Richard, Duke of Cornwall, brother of Henry III., 1216-1272, derived immense profits from the mines, the produce of which was subject at this period to a royalty of 40 shillings for every £1,000 in value, payable to the duke, and twice a year all the tin produced had to be brought to appointed places, where it was officially stamped and weighed.

The Jews being banished from the kingdom in the eighteenth year of Edward I., 1290, the mines were again neglected till the gentlemen of Blackmoor (lords of the seven best tithings stored with tin) obtained a charter from Edward, Earl of Cornwall, with more explicit grants, privileges, etc., among them that of receiving as their own due and property the toll tin, that is 1-15th of all the tin raised.

The kings and dukes of these times would appear to have treated this industry very lightly, for it is recorded that Edward I., in 1305, in the thirty-second year of his reign and the 36th of his age, mortgaged or assigned his due for one year to settle a wine bill for £750.

In 1376 the tinners were able to obtain protection by act of Parliament, but the civil wars following (viz., the Wars of the Roses) the mines were again very much neglected. When, in 1485, these wars ceased, England became more settled and tin mining became more profitable and prosperous.

Prudent Queen Elizabeth (1558-1603) appears to have taken more interest in the mines than her predecessors, for she sent to Germany and brought over German miners, by whom many of the Cornish processes were very much improved.

Very little has been written, and next to nothing can be ascertained, of the progress of this trade from 1600 to 1700.

In the reign of Queen Anne (1702-1714) it is recorded that the queen had in stock 5,000 tons of tin, equal to five years' consumption, demonstrating the existence of hard times for the producers, or proving that the queen was a "hard bargain" to deal with.

It was after the death of Queen Anne, but there appears to be no record of the exact date, when eastern or foreign tin first arrived in Europe to compete with the Cornish product, but as early as 1760 small quantities of Banca tin were received in Holland.

In 1787 the importation of Banca tin to Holland was so much beyond their own requirements that the Dutch shipped a quantity to England, but that same year the increase from the Cornish mines was about 500 tons.

The market was, however, relieved by the East India Company taking 800 tons to China, where a market had already been opened for it.

The trade with China, however, was brought to a close in 1817 by the return of Cornish tin from China

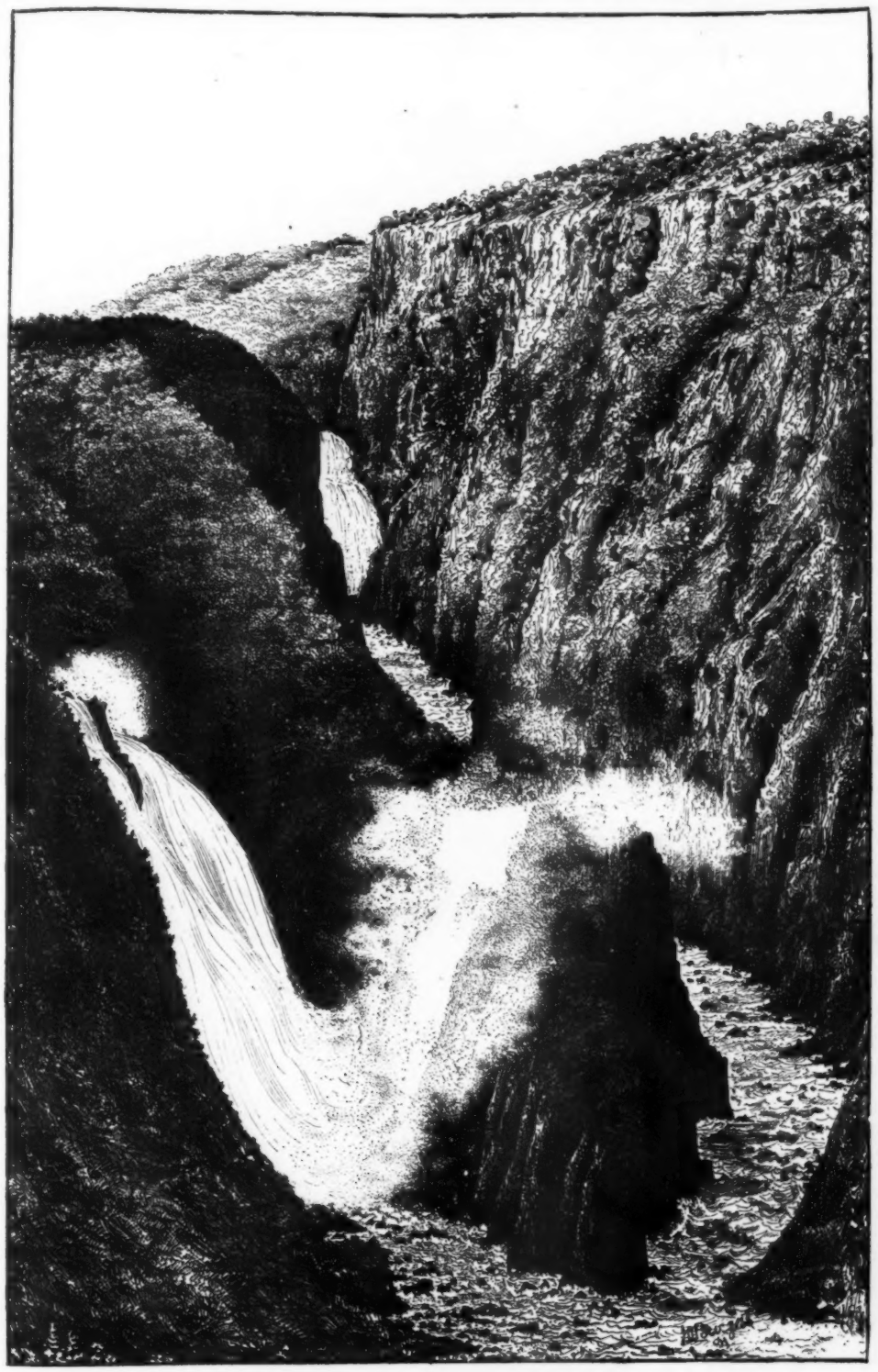
to London, and the underselling of the mine product in the home market.

The history of tin from that date to the present day is only a question of figures and statistics, which are beyond the scope of this article.

The discoveries of tin in Germany 500 years ago, which never became important, were practically abandoned several years since.

Cornwall has safely defied all competition from Europe and the East, but the cloud which threatens her has risen in the South, in her own colonies.

In the year 1872 large discoveries of surface tin ore were made in Queensland and New South Wales, and all at once a new supply appeared to find a sale in Europe.



THE WOLLOMOMBI FALLS.

In this country the deposits of tin in Dakota and California promise to yield a large supply of the metal.

WOLLOMOMBI FALLS.

ONE of the most picturesque spots in New South Wales, though little known to tourists, is the Wollomombi Falls. With the exception of those whom business calls to that part of the country, few visit it. Still the scenery would well repay the traveler, and afford a glimpse of nature in one of her reckless moods.

The falls are distant about twenty-nine miles from Armidale, and to enjoy them thoroughly the tourist should first visit the points of interest in the surrounding country.

Armidale itself is a very pleasant little city. It is on the northern line, some 358 miles from Sydney, and 3,113 ft. above sea level. After the long journey by rail, it makes a very pleasant stopping place for a day or two. The first point of scenic interest to be visited is the Gara Falls, which may be better described as pretty than grand. Twelve miles from the town are the Dangar Falls, also well worth inspection, and it will pretty well occupy a day to see them properly. After them, in a gradually ascending scale of picturesque beauty, come the Wollomombi Falls, a graphic sketch of which appears in the current issue. They are situated at the confluence of the Wollomombi and Chandler Rivers. The depth of the falls has never been officially ascertained, but it is supposed to be something over 1,500 ft. The scenery around is majestic and grand. Jutting cliffs many hundred feet deep stand out in bold prominence on both sides of the gorge, while between them lie rocky ravines, waist deep with ferns, and fringed and bordered with shrubbery and taller vegetation. It is as if nature wished to mark the contrast between the barren grandeur of the mighty rocks and the lavish wealth of her vegetation.

Streams of water are always flowing over the falls, but when the wet season sets in, and the Wollomombi and Chandler become swollen by floods, the united torrents of the two rivers pour in a vast cataract from rock to rock, and basin to basin, until they are at last lost to sight in the resounding depths.—*Ill. Sydney News.*

THE TROUT PARASITE OF YELLOWSTONE PARK: ITS RESEMBLANCE TO TÆNIA SOLIUM.

THE lake trout in Yellowstone Park are infested with worms, concerning which an interesting paragraph appears in the last annual report of Secretary Noble, of the Interior Department. The waters of the Yellowstone region were visited recently by Professor Edwin Linton, who, in conjunction with Professor S. A. Forbes, has reported informally concerning the probable nature of the trout parasite. These investigators believe that the parasite will be found to be a larval, or immature and non-sexual, form of animal life, resembling the "measles" stage of *Tænia solium* in the swine. In other words, this trout parasite is an example of that order of worms which complete the cycle of their life in two different animals. Having this hypothesis in view, Professor Linton began a search for some form of animal which by feeding upon the trout in a raw condition would be likely to become the host of a sexually mature intestinal worm corresponding to the cystic and larval stage observed in the trout. He examined a number of the fish-eating birds occurring in the vicinity of the Yellowstone Lake, and finally hit upon the pelican as the probable final host in this alternation of generation. The pelican was found to have an intestinal parasite which had eggs and which appeared to belong to the same genus as the form in the trout. Collateral proof was obtained by opening the stomachs of some of these birds and finding therein ingesta of trout. These birds, four in number, were shot at Molly Island, in the southerly part of the lake, a favorite breeding place to which the birds resort in great numbers. The pelican is, moreover, the only fish-eating bird that occurs on the lake in large numbers. It is understood that this bird consumes the fish of every description that happens to be left dead on the shores of the lake. The worm-infested trout is believed to be confined to a very limited and well defined region of the waters. Mr. Linton's research was conducted with only an imperfect supply of appliances, and he expects to make a more careful examination of the materials he was able to collect and bring home.

Appropriate to this item is the fact that it was reported some months since that the trout of Loch Katrine, in Scotland, were infested with the tape worm parasite or larva, and a certain amount of "scare" was created in the district which takes its drinking water from that Loch, lest the citizens should serve as the unwilling host for maturing the incomplete tænia, and lest an "epidemic" of tape worm might occur. Our impression is that this anxiety was set at rest by showing, as some of the investigators had the means of doing, that tænial disease happened to be less frequent among the city folk supplied from the Loch than among the country residents who had their independent water supplies. And, further, the thought suggests itself that the parasite may not have been the *Tænia solium* after all, although resembling it, and it may have been perchance the same animal whose life history Mr. Linton has partially set forth in the *fontes et fauna* of our far West.

One peculiarity of the Yellowstone Lake trout not mentioned above is that the larval parasite may occur in the same fish of very different sizes, from that of a small cyst not larger than a small sized shot to that of larvæ that grow in the muscular tissue to be several inches in length.—*N. Y. Med. Jour.*

THE VOLCANO OF BOGASLOV.

LIEUT. J. C. CANTWELL, of the United States Navy, has written an interesting article in the San Francisco *Chronicle*, from which the following facts are condensed.

Geographers have for nearly a century known the little island of Bogaslov, one of the Aleutian chain, just north of Unimak Island. Behring discovered it, and described it as a fiery, isolated mountain, belching forth volumes of smoke and flame. Later voyagers went so far as to say that the sea was heated by subterranean fires for miles around, and that the ejected stones and lava had made navigation dangerous. There are some maps to-day which show a reef extending for five or six miles along the southern side of Bogaslov.

Forty years ago the smoke and fires of Bogaslov could no longer be seen. The volcano became extinct and was then merely a huge, grayish cluster of rugged rocks rising to a height of 250 feet. One day a schooner captain, who was skeptical of the existence of the reef which Russian sailors had reported, steered a course between the volcano and Unimak Island. He not only was unable to find the reef, but he could not touch bottom anywhere with a forty-fathom line. The once fiery Bogaslov became a favorite haunt of sea lions, and the natives of adjoining islands often went there for sea lion skins and boat loads of eggs, for myriads of sea birds chose this lonely spot to rear their young.

This state of affairs continued until the summer of 1882, when native hunters reported that they had seen smoke issuing from the volcano. In 1883, Capt. Anderson, who was trading along the Aleutian chain, had occasion to pass near Bogaslov. When yet thirty miles from the island he saw vast clouds of smoke. He steered a course toward the island, and soon he was close enough to see that the smoke did not issue from the old volcano, but from a new mountain that had risen from the sea less than half a mile north of old Bogaslov. The new and old mountains were connected by a narrow beach or isthmus. The new volcano was pouring forth dense clouds of smoke, and fine volcanic dust and ashes were scattered far around, while sulphurous flames leaped out of huge crevices in the new mountain, and the sea for two miles around was discolored by the matter which was sprinkled over it.

Of course his story created the greatest interest, and early in the spring of 1884 Lieut. Cantwell and Dr. H. W. Yemans were landed at Bogaslov from the United States steamer Corwin. The new mountain was in active eruption, but there seemed to be nothing more dangerous than steam and sulphurous flames issuing from numberless vents in the sides of the crater. The men were landed on the narrow beach between the new and old mountains. The beach was found to consist of a mixture of sand and small oolitic stones. It was evidently of much greater age than the new mountain, and previous to the eruption had apparently been a partially submerged spit jutting out from the northeast face of old Bogaslov. An isolated pinnacle of rock 87 feet high, which had probably formed the termination of this spit, had been elevated by the recent upheaval. It received the name of Sail Rock.

The sides of new Bogaslov were found to rise with a gentle slope to the crater, and the ascent at first appeared to be easy, but the thin layer of ashes, formed into a crust by moisture and heat, was not strong enough to bear a man's weight. At every step the feet of the explorers sank into a soft and almost impalpable bed of dust, which arose in clouds and

nearly suffocated them. The heat of the ashes as they approached the summit became unbearable, and they were forced to pick their way over rocks whose surfaces, being exposed, were cooler and afforded a better foothold. A thermometer buried in the sand half way up the side of the mountain registered 191°, and in a crevice the mercury expanded so rapidly that it burst the bulb, and the solder on the tube was fused. The explorers estimated the temperature at this spot to be over 500°. Steam and vapor were escaping from numerous vents on all sides of the cone, and around these apertures a thick deposit of sulphur had been made, the fumes of which were almost unbearable.

"We pushed forward now," says Lieut. Cantwell, "with the utmost precaution toward what appeared to be a large fissure in the main peak or wall of the crater, if any existed, intending to pass through it and gain a better view of the inside of the cone. As we progressed, the dull noise which was perceptible on the exterior of the cone as a low purring sound became louder and louder, until at last it filled our ears with a muffled, humming reverberance, which is altogether impossible to describe. When we were within some fifty feet of the fissure, a sudden gust of wind sent a cloud of sulphurous smoke, ashes, and vapor down the little cañon in which we found ourselves and compelled us to beat a retreat."

A curious fact which the lieutenant observed was the entire absence of lava. There were no shells and but little seaweed on the beach. A walk of a third of a mile along this beach brought the explorers to old Bogaslov. Millions of sea birds were nesting in the crevices of the cliffs of the old mountain, though not a sign of life of any kind had been seen at the new mountain.

Lieut. Cantwell again visited the new volcano last summer on the United States steamer Rush. He found that during the seven years since his last visit many changes had taken place in the new mountain. Although still in a state of eruption, new Bogaslov has sunk into the sea several hundreds of feet, and its highest point is not over 250 feet in height. No accurate measurements could be obtained on account of the dense clouds of vapor which hung around the upper portions of the islet. The isthmus which once connected the old and new mountains had sunk out of sight, carrying with it Sail Rock, which at one time stood eighty-seven feet above sea level. In fact, the place where he had walked on dry land seven years before was now covered with seven fathoms of water, and the sea had made a passage where the two volcanoes were then connected by a beach, deep and wide enough for a moderate sized ship to sail through.

THE annual aggregate number of letters transmitted through the post-offices of the world may be estimated at 8,000,000,000.

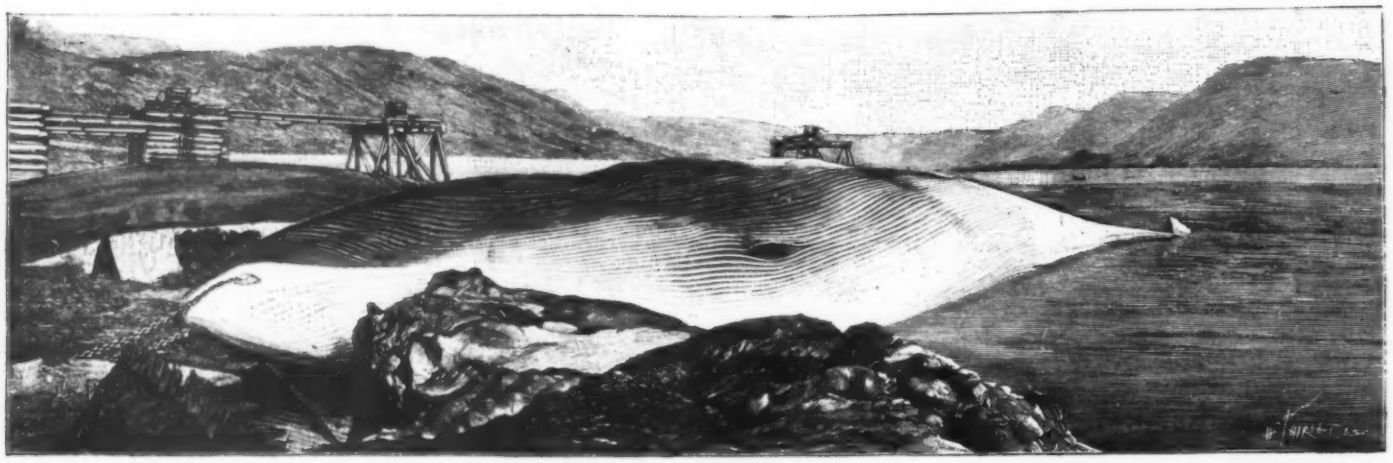
THE WHALE FISHERY.

PROF. POUCHET, faithful to his studies upon the larger animals of the sea, begun in Lapland, has just made a new journey in the North to the dolphin and whale fisheries established upon the Faro Islands and in Iceland, and has been kind enough to send us a few of the photographs taken at his request by one of his traveling companions, Mr. Vermaes, a Dutch engineer.

At the Faro Islands the dolphin fishing is somewhat aleatory. It happens in certain years that the large herds of these animals, impatiently awaited by the inhabitants, do not show themselves. As soon as one of these herds is sighted in the fiords of the archipela-

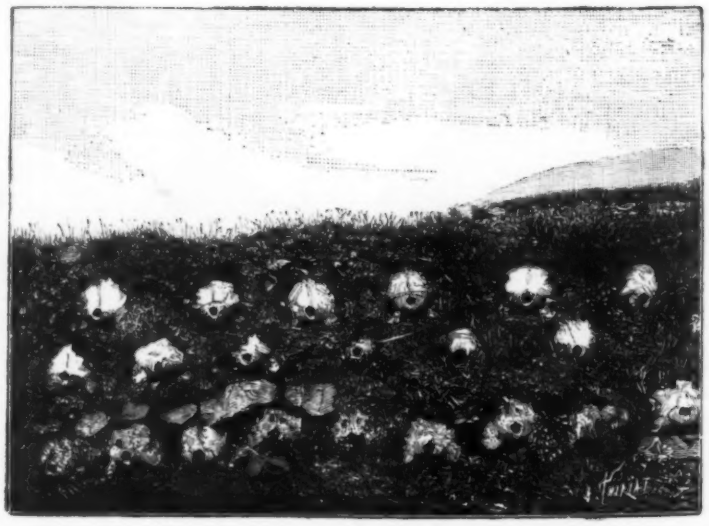
WHALE'S HEAD, BASE UPWARD.

CUTTING UP A WHALE.



A WHALE UPON SHORE.

FURNACE AND KETTLE FOR MELTING THE BLUBBER OF DOLPHINS.



WALL FORMED OF DOLPHINS' HEADS.

go, it is hemmed in and driven ashore at the head of the nearest bay. The melting of the blubber is done in the open air, in a primitive furnace set up upon the bank with a few dry stones. Sometimes this furnace is provided with a small chimney. An iron kettle, and, around it, some pails and the casks to be filled with oil, complete the installation.

The dolphins are sometimes so numerous that the director of a large factory at Klaksvig took it into his head one day to make use of their skulls in the construction of a wall. These skulls are all arranged with the posterior of the occiput, with its large aperture, outward. But time has put in its work, and the skulls have become pierced with two eye-like apertures in the thin part on each side, a little above the occipital

aperture, and moss having grown at hazard in the latter, which corresponds to a mouth, the appearance of the whole is very whimsical.

In Iceland, the whale fishery is, on the contrary, regular and perfectly organized. It is carried on, as in Lapland, by means of small steamboats which beat about the sea, kill the whales and tow their big bodies to works established upon a part of the coast where the water is always calm. These steamboats, which are constructed in such a way that the engine shall make as little noise as possible, carry a gun in front loaded with a big harpoon re-enforced by a shell. As soon as a whale is sighted by the watch, the boat is so maneuvered as to make it approach it. The captain, standing motionless near the gun, awaits a favorable moment and then fires. As a usual thing, the animal

FIN OF A WHALE.

is not fired at from a distance of over fifty feet, and it is immediately killed by the shell, which explodes in its body. It is then lashed to the larboard side of the boat, which steams for the shore. The works overlook a gently sloping beach which serves as a channel. Nothing can give an idea of these channels, when several whales, as is not rarely the case, are cut up at the same time. Here we see piles of intestines around those huge bodies that have been landed as well as possible upon the side, sometimes upon the back, exhibiting a belly marked with long wrinkles, and a mouth partially open, with a huge chin advancing much beyond the upper jaw provided with whalebone.

The animal is cut up at low tide. The work is always done in the same way, and methodically. The blubber is first removed in large longitudinal slices. A whaler detaches them with a long-handled knife which he holds with his two hands. During this time windlasses draw the slice of blubber upon the sand, and other windlasses draw it up an inclined plane to the choppers, which cut it into small fragments, and to the kettles, where it is tried out.

The whalebone is afterward removed, as are also the two jaws, which are set aside to be worked later on. The latter contain but little oil, and present, on the contrary, an extremely strong bony framework. They are stowed away in a corner until the end of the season, when, with the other large bones of the carcass, they are sent to some animal charcoal manufactory.

There are at present three whale fisheries established in the fiords of the northeast of Iceland in the vicinity of the small city of Isafiord. This latter, built of planks, occupies a tongue of earth which cuts in two a small fiord, having behind the city an admirable port into which the largest ships can enter.

The sides of the mountains that surround the fiords, like all of those of Iceland, are furrowed by ravines in which snow remains until the middle of summer. Those shown in our engraving were once attempted by a number of alpine climbers, who accomplished the feat of ascending through one of these passages and descending through another. This ascent, which was entirely useless, since the mountain is accessible at the other side, was not, however, accomplished without grave difficulties and serious dangers.—*L'Illustration.*

SOAP BUBBLE BLOWER.

THE blowing of soap bubbles has always been one of the favorite amusements of children, and so a host of combinations have been devised to permit of obtaining double, oblong, or concentric bubbles, as well as bubbles containing a bird, a statuette, etc. Up to the present, the blowing has always been done by the mouth, thus causing a certain fatigue, especially when it is desired to obtain bubbles of a large diameter.

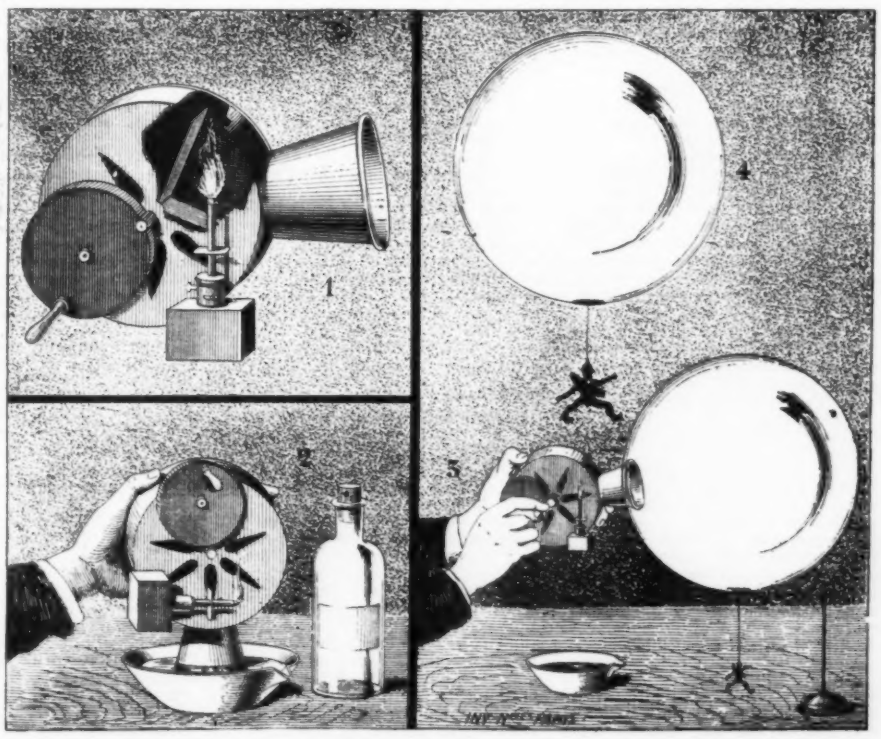
The small apparatus illustrated herewith does away with this inconvenience, and permits of blowing bubbles twelve or fifteen inches in diameter without the least effort.

It consists of a small nickel-plated zinc blower set in motion by the action upon each other of two disks, the larger one of which is actuated by a winch. In one side of the apparatus there are apertures, through which the air enters the blower after having first been heated by an alcohol lamp. The hot air makes its exit through a conical mouth piece that has been dipped into soap suds. On turning the winch with a continuous and not too rapid a motion, there is seen to form at the extremity of the mouth piece a bubble, whose diameter rapidly increases, and with which it is possible to obtain the most charming effects.

At first, as the bubble is filled with hot air, it will, contrary to what usually happens with soap bubbles, have a tendency to ascend, like a true hot air balloon. If it is desired to form bubbles heavier than the air, it will suffice to remove the lamp.

The ascensional force of this hot air balloon is sufficient, when the bubble is somewhat strong, to lift a small figure attached by a thread to a rubber disk. It suffices to first wet the latter with the soap water and place it upon a support of the form shown in the engraving to the right. After the bubble is formed it is brought into contact with the disk, which attaches itself to it. Upon then inclining the apparatus so as to detach the bubble, the latter will rise and carry its burden to the ceiling, against which it will burst. In the open air, the weight of the figure will not allow the bubble to rise to a height of more than fifteen or twenty feet, but the bubble itself is capable of rising easily to a height of ninety feet.

With this apparatus it is also possible easily to obtain double bubbles. For this, it suffices to fix a wire across the mouth piece according to the vertical diameter. After blowing, as we have said, the apparatus is given a slight motion sideways, and the two bubbles, one superposed on the other, will be detached.—*Les Inventions Nouvelles.*



APPARATUS FOR BLOWING SOAP BUBBLES.

THE CENTRAL LATERAL MOTION OF THE WORLDS OF SPACE.

To the Editor of the Scientific American:

Through the columns of your valuable paper I desire to take issue with a theory of Prof. Alexander Winchell's, advocated in an article entitled "The Sun Cooling Off," originally published by him in the *Methodist Magazine*, and republished in the SCIENTIFIC AMERICAN of Oct. 10, 1891; and at the same time to make known to the world certain astounding discoveries in astronomical science of which I am the author.

The tenor of the professor's article is that of the prevailing theories based on the creation of worlds and their final destruction, and to be found in nearly all the geological and astronomical books of the day; consequently it is not necessary in this connection to recapitulate his particular article and thereby occupy space unnecessarily.

Heat is a result, not a cause primarily. It is caused by impact, by attrition, by pressure and by chemical action brought to bear upon caloric, which latter word I use in the sense of heat in a latent or inactive condition, such, for instance, as is found in a block of ice. Caloric may be some invisible thing, comparable to attraction, existing in a quiescent condition and pervading and filling the interstices of all matter, or it may be in the nature of atoms, so minute as to constitute the *ultima thule* of divisible matter. Whatever its nature, when aroused to action, it results in the degrees of warmth, heat or fire. This much is indisputable and commonly known.

There would be no warmth, even in all the universe, if there were nothing to excite caloric to action. It is the impact of the sun's magnetic rays (so called) upon the surface of the earth that makes it warm as a whole, and wherever those rays strike their blows the most direct there is the greatest force and consequent amount of warmth, because there the earth's caloric is caused the greatest amount of agitation. At the north and the south poles the surface of the globe is so curved away from the sun's direction that the caloric of those localities is not reached or touched at all at a certain time of the year, by the impact of the sun's rays. Consequently it remains undisturbed and inactive, therefore intense cold prevails. At the equator the reverse of all this is true, and opposite conditions consequently are the result.

The rays which reach the earth from the astral bodies outside this solar system are so retarded by counter attractions of the bodies of space, that they are detained in their course, and consequently ultimately reach the earth in a weakened and comparatively powerless condition; consequently the earth's caloric is but very slightly agitated by rays coming from astral directions, as scientific measurements prove to be the fact. All of the foregoing facts are indisputable, and in accordance with what is well known by men of learning.

Now the condition of the sun is, to-day, just what would be that of the earth if cut off, by distance or otherwise, from the approximate—near-by—rays, or influence, of the sun, with their powerful impact, *a frozen mass eternal*, as a whole. The granulations, resembling rice grains, or willow leaves, observed by astronomers, are, without doubt, the surfaces presented of vast fields, and the limb protuberances immense mountains of ice and snow, which cover the sun's surface. The intensest cold of the whole solar system must prevail there. The planets of the system united could not send, or return, rays with force enough to the sun to warm one square mile of its surface; and the detained rays of the astral bodies arrive at the sun in too weakened a condition to exert a force worth the mentioning. There being, therefore, no power from a foreign source brought to bear to excite the sun's caloric to action, as a whole, a cold must prevail there which is many hundreds of degrees below zero—in fact, too intense for human conception. That the sun's rays, even, which reach the earth are intrinsically cold, is proved by the fact that a burning lens constructed of ice will as readily set fire to any proper material as though made of glass. Prof. R. W. Emerson, of the College of Mines and Metallurgy, Missouri, once accomplished this experiment successfully.

But, while it is true that the intensest cold known to man prevails at the sun, it is equally a fact, as revealed by the spectroscope, that the intensest of heat also prevails there. Time, however, will show that while the former is general, the latter is local in character. For all physical phenomena there must exist an adequate natural cause, and this is eminently true of the phenomena of the sun. Extremes meet there which round up and emphasize the old adage.

And now the earth must be reverted to, in order to explain the extremes which exist at the sun, and hereby hangs the tale of the discovery above alluded to, and the one fraught with more importance to the human family than all others combined.

1. In the frigid regions of Alaska, according to the reports of Professor Muir, of Muir glacier fame, there are to be found the remains of tens of thousands of dead elephants, mastodons, and other tropical animals. Also, upon the northern coast of Siberia, hundreds of these animals are washed ashore yearly, and every summer their ivory is gathered by the inhabitants of that country and made an article of commerce. Other explorers have found, in the coal measures of Melville Island, in the midst of the frozen arctic circle, the remains of a gigantic ultra-tropical vegetation consisting of tree ferns, lycopods, etc.

2. For thousands of miles, radiating to every point of the compass, from Quito, Ecuador, South America, years ago, Professor Louis Agassiz found traces of glacial action existing under what is now the vertical rays of a tropical sun on the equator itself. Other explorers have since confirmed his discoveries. Vast masses of ice once existed in that region. The equatorial measurement of the earth from that point through to the opposite side lacks, in round numbers, two miles of its proper measurement to correspond with the rest of the equator.

3. East and west from the above point, at 90 deg. distance each way, there may be traced a line encir-

cling the globe, and bisecting both of its poles, along which the entire distance may to-day be found the remains of the flora and fauna of an ultra-tropical production, wherever there is land, regardless of present climatic conditions.

4. All over the eastern and western hemispheres are the unmistakable evidences of the world having been flooded with oceans of waters, at a comparatively recent date, and in both are also found deposits and terminal moraines, extending from the arctic circle down to about the fortieth parallel of latitude, which prove, positively, that the earth has gone through a glacial epoch which covered 100 deg. of its surface with fields and mountains of ice, thousands of feet in height and depth.

Very much more of the earth's physical phenomena, of as amazing a character, might be cited, did the limits of this article permit, but enough is given for the purpose required.

Many have been the speculative theories advanced by the scientific world, to account for the existence of the above mentioned phenomena, and to assign a natural, adequate cause therefor. But all the theories have thus far failed, each successive one having demolished its predecessor, until at last the universal sentiment prevailing is voiced by Prof. G. Frederick Wright, where he says, in his "Ice Age," "The sum of the whole matter, so far as theory is concerned, seems to be that as yet we do not know what was the ultimate cause of the glacial period." So far as the delirious imaginings of supernaturalists are concerned, the intelligence of the age promptly rejects them.

Climatic conditions on the earth are almost wholly governed by the position it occupies to the sun, and to change climatic conditions one of two things must first take place, viz., either the sun must sweep off in a direction lateral to the earth's orbit or the earth must turn over in a direction at right angles with the plane of its diurnal motion, a distance of 90 deg. in either case, to make the most radical change. That the former action cannot take place is evident from the fact that the sun's attractive power would carry the whole planetary system with it, and there would practically be no change of relative position, for there is no known foreign power sufficiently great to hold the earth fast and unchangeable under such circumstances. That the latter of the two things has taken place is unquestionable, for facts prove it. In no other way could the flora and fauna of an originally ultra-tropical region be thrown to the frigid zone, to perish under the changed climatic conditions which would be a natural consequence; in no other way could a reasonable account be given for the aforetime presence, in what is now an ultra-tropical region, situated right under the vertical rays of an equatorial sun, of thousands of miles of ice; in no other way can the earth's present flattened equator be accounted for, showing that it was once subject to centripetal force; for no other known power could have produced such a result; in no other way can a natural, adequate cause be given for the great cataclysms which have flooded the earth, in ages past, and left their unmistakable traces upon its surface to tell the tale to-day; in no other way can a satisfactory reason be given for the fossilized existence, entirely around the land portion of the globe, independent of present climatic conditions, of the flora and fauna of an ultra-tropical region, and in no other way can the glacial epoch be accounted for only under the swaying action of the earth, as it has rocked temporarily back and forth, under the influence of the law of momentum, and that other influence which will be mentioned hereinafter.

Of course, when the earth, turning laterally upon its center, reverses the position of its poles, and its equator, to a position 90 deg. distant from its original, there is a consequent and accompanying change of form to the amount of 26⅛ miles, reproducing the form of an oblate spheroid to that extent at right angles with its former position, and this is caused by the united action of centripetal and centrifugal laws. As a consequence of these laws, acting within and upon the earth, vast mountain chains will be wrinkled up in certain directions and sunk in others, and, as a consequence of the awful and inconceivable pressure and attrition brought to bear, volcanoes will be brought into existence, some of them of tremendous size and of great extent, which will burn for a time, and then become extinct, in consequence of their heat returning to its original latent condition—of caloric—in the absence of further exciting cause.

If it were asserted that this third (principal) motion was peculiar to the earth alone, there would be a basis for a well founded suspicion as to the correctness of the assertion made, because the principle is well established that the laws of nature are general in their application, action, and character, particularly those relating to the movements of the worlds of space. But no such assertion is made; on the contrary, it is asserted that all worlds—be they suns, planets, or satellites—are governed and controlled by the same law, and subject to the same periodic motion, though occurring in different cycles of time. In proof of this, the cases of Saturn and of Jupiter may be cited, and perhaps Uranus and Neptune also. In regard to Saturn, Prof. Richard A. Proctor says, in his "Other Worlds than Ours," p. 160: "If it can be shown that Saturn's globe is subject to changes of figure [owing to its diurnal revolution], perceptible even across the enormous gap which separates him from the earth, it will at once be admitted that he can hardly be regarded as a globe conveniently habitable. Now, I have very little hesitation in saying that evidence of the most conclusive kind exists in favor of this strange [apparent] mobility of figure. It will presently be seen that it is with the observations of no mere amateur astronomers that I have to deal in endeavoring to establish as a fact that which has been commonly spoken of as an illusion—the assumption by Saturn of his so-called 'square-shouldered' figure."

"It was in April, 1805, that Sir William Herschel first called attention to this peculiarity. The planet, which had always presented to him an elliptical figure, exhibited a strangely distorted aspect. A well-marked flattening at the equator [similar to the earth's], accompanied by an equally well-marked flattening at the poles [true of the earth], gave the planet's globe an oblong figure (with rounded angles), the longest diameters having their extremities in Saturnian latitude 48° 20'—so exactly was the great astronomer able to indicate the nature of the [so-called] deformity, owing to its well-marked character." . . .

"On August 5, 1803, Schroeter found Saturn not perfectly spheroidal in figure. Kitchener says that for a few months, in the autumn of 1818, he saw Saturn of the figure described by Sir William Herschel, and that with two different achromatics. At this time the ring must have appeared too narrow to account for the appearance as due to illusion. On one occasion Sir George Airy had a similar view of Saturn. He remarks, also, that a person unacquainted with Herschel's observation remarked spontaneously on the flattened equator of the planet," etc.

There are still other authorities and proofs, but space will not permit. Enough is given to prove the assertion, so far as Saturn is concerned. Like proofs exist so far as Jupiter is concerned, and Uranus does not fall short in other respects, though so far away. As hereinbefore indicated, the very fact of a planet's existence with a flattened equator proves incontestably that it has been placed under the power of centripetal force by having stood in the position of north and south—a direction at right angles with its present, for no other known power could have produced such a result. The great dark red spot dying out upon the southwest portion of Jupiter's surface can be shown to be simply an enormous volcano of temporary existence, caused by the action of centripetal force, brought to bear, by the planet's central turning and its consequent change of form, in a direction at right angles with its former form. The dim, shadowy rings of Uranus, 1,800,000,000 miles from the sun, as once seen by Sir William Herschel, so dimly that he afterward doubted the accuracy of his own observations, because unconfirmed by subsequent observers, are but a parallel production of those of Saturn, and a result of the same cause. No planet of this system exists which has not repeatedly had its Saturnian rings. These rings are but of temporary existence at their best, and will all, comparatively, soon pass away. They are caused by a limited demagnetization. Upon the central turning of a planet it is placed in a position at right angles with that which it occupied before turning; consequently the magnetic rays or currents of the sun are surrounding the planet in a direction at right angles with their former. As a natural consequence of this change of direction in the sun's magnetic rays, the planet becomes demagnetized to a limited extent. Centrifugal force remaining the same as before, owing to maintained diurnal motion, particles great and small are thrown off, and form rings around the planet to the extent of the weakness of its attractive power, while the balance goes into the solar system to be gathered up in after ages, as the given planet becomes recharged, and thus meteors and aerolites are gathered up, and the rings of planets disappear.

But, inadvertently, this subject has been continued farther than was necessary to simply account for the actual local heat of the sun, and which heat, with all its intensity to propel it, has never yet reached the earth, nor any other planet, or body of the solar system, the spectroscope apparently to the contrary notwithstanding. The local heat of the sun is mainly situated in the neighborhood of both sides of its equator, and is caused wholly by volcanic action, which, in turn, was naturally caused by the awful pressure and attrition which was a necessary and inevitable consequence of its central turning and consequent change of form ages ago. The spots upon the disk of the sun, seen by astronomers, are but the mouths of tremendous volcanoes and the smoke issuing therefrom. No heat, as above remarked, comes to the earth from them. That which is recognized as heat, here coming from the sun, is but a result of the impact of its magnetic rays (for want of a true name) upon the caloric of all earthly matter, or things material. There is absolutely no heat radiated from the sun in any direction, and its magnetic rays are only reciprocal—alternate—between existing material bodies, such as the planets—their satellites, asteroids, the detritus and debris of the solar system, comets, with, perhaps, a shadowy influence to and from the astral existences. The sun's corona, as seen during eclipse, is of the same nature and character as that of the blazing star in the distant heavens, which suddenly springs into existence, upon its central turning, and gradually dies away. Every star of the universes of space has been going through that ordeal, periodically, to all eternity. The volcanic heat of the sun disturbs and to a certain extent destroys the magnetic rays of those localities, and there results magnetic storms upon the earth.

The cause of the central, lateral, motion of the worlds of space, periodically, is primarily the cyclic revolution of their line of apsides. In the case of the earth it takes about 20,900 tropical years for this line to complete one entire revolution. Its zero point is located in that part of its orbit where the earth is brought into perihelion at the time of the autumnal equinox. The earth then stands flatwise to the sun, charged with a magnetic force derived from more than seven million six hundred thousand diurnal revolutions, with one pole rendered positive and the other negative to the sun's influence. The result is that one pole is attracted while the other is repelled and the earth is turned over. The earth's last catastrophe occurred at a time at which certain chronologists have dated the creation of the world, the zero point of the astronomer's great year, and its recurrence will be about 15,000 years hence. And this is what has limited, and will always limit, the earth's population throughout the eternal ages of its existence.

Afar in the unknown depths of the fathomless profound, exists a mighty center around which the sun, with his grand retinue of dependents, revolves in an orbit vast beyond human comprehension, and yet held and controlled by that far-reaching attractive power which knows no bound to its influence. Whirling onward in its orbital path, surrounded by the mighty suns of the astral depths, the sun of this system must have his line of apsides, fateful with his catastrophe, but who shall measure it, and who fix his periodic time? Alas! alas! none but the Infinite.

MARSHAL WHEELER.

ACCORDING to Clark, the equatorial semi-diameter is 20,926,202 feet, 3,963·296 miles, and the polar semi-diameter is 20,854,895 feet, 3,950 738 miles. One degree of latitude at the pole, 69·407 miles; one degree of latitude at the equator, 68·704 miles.

SEWAGE DISPOSAL FOR TOWNS AND CITIES.

THE effective disposal of sewage is so important a matter for the inhabitants of many of our towns and cities that we think our readers will be interested in a description of the new works lately completed for the drainage of five parishes near London. We quote from *Engineering*:

The Richmond Main Drainage and Precipitation Works have been constructed for the purpose of preventing the pollution of the River Thames by sewage from Richmond, Mortlake, Barnes, Kew, and Petersham. Richmond is the district of the Urban Sanitary Authority, and Barnes, Mortlake, Kew, and Petersham form that of the Richmond Rural Sanitary Authority. The sewage of these places has hitherto been partly discharged in its crude state direct into the River Thames, greatly polluting its water, and partly retained in cesspools, connected to the houses, to the serious detriment of the health of the inhabitants. To remedy both these evils these works have been constructed.

The areas, with the present population and ratable values of the contributory parishes, are as follows:

Parish.	Area. Acres.	Ratable Value. £	Population in 1891.
Richmond	1210	176,500	22,684
Barnes	940	60,631	8,445
Mortlake	1883	52,153	7,714
Kew	298	18,065	2,076
Petersham....	652	8,707	629
Total.....	4983	316,056	41,548

The works provide each of the parishes of Barnes, Kew, and Petersham with an outlet, into which it can discharge its sewage matter, the outlets being placed at a sufficiently low level to drain the whole district. In like manner Richmond and Mortlake have been provided with several such outlets for the reception of their sewage. These outlets for the five parishes are connected together by main intercepting sewers.

The sewers vary in size from 12 in. in diameter up to 40 in. in diameter. They are all circular in form and are constructed, according to the situation, of stoneware socket pipes, laid in and surrounded with Portland cement concrete, cast-iron socket and spigot pipes, also laid in and surrounded with Portland cement concrete, and Portland cement concrete sewers lined with radiating Staffordshire blue brick inverts and gault brick arches. The size of the prism of concrete surrounding the sewers and pipes is such that it gives a minimum thickness of 6 in. round the stoneware pipes, 6 in. round the iron pipes, and 8 in. round the brick sewers. The iron pipes are used when the ground is treacherous, particularly along the river bank at Richmond, where there is a tendency for the earth to slide. The whole of the bricks employed in the sewers and the manholes were purpose-made pressed bricks, and were set in Portland cement.

The sewers all have good self-cleansing gradients, varying from 1 in 250, for the smallest sewer, to 1 in 1200 for the largest. The total length of main intercepting sewers is a little under 5 miles, the depth below the surface of the ground varying from 20 ft. to 45 ft. Excepting two or three short lengths constructed in the gravel, the sewers have been laid in the London clay, which underlies the water-bearing gravel formation of this district. With the exception of two short lengths they have been constructed in tunnel driven in the clay, shafts being sunk through the gravel into the clay for the purpose of tunneling, which shafts were eventually used for manholes and lampholes. Flushing is provided for where required by the admission of Thames River water at the points where the sewers commence, and by penstocks placed in the sewers. To afford ventilation there are used "Holman-Keeling's" patent sewer gas destructors, and these are supplemented by connection with the chimney shaft at the pumping station. There are also open gratings in the manhole covers, which will chiefly serve as fresh air inlets to the sewers.

The sizes of the sewers have been calculated upon the hypothesis of excluding from them as much rainfall and subsoil water as practicable, and they are only intended to receive a limited quantity of such waters in addition to the sewage proper. They are capable of conveying the sewage from a population of 80,000 persons, which is the estimated future population of the entire combined districts, one-half the flow to pass in six hours. The outfall sewer has a discharging capacity equal to 11,000,000 gallons in twenty-four hours.

The sewage will flow by gravitation to one spot in the northern corner of the parish of Mortlake, where the invert of the outfall sewer and pump chamber is 25 ft. below ordnance datum. To this level the whole of the sewage of the entire district between Hammersmith Bridge and Putney boundary, on the northeast, and Ham House and Ham boundary, on the southwest, a distance of five miles, will flow by gravitation. The dry weather flow of sewage from the present population is estimated at 2½ million gallons per day and the wet weather flow at 5¼ million gallons per day.

The site acquired by the board for the pumping station and disposal works is situated in the northern corner of the parish of Mortlake, on the bank of the River Thames. It comprises, in the whole, eleven acres, of which about seven acres only are as yet brought into use, the remainder being reserved for the extension of the works to meet increase of population. It is a low-lying piece of ground.

Those parts of the pumping station, precipitation and disposal works which it would be impracticable to enlarge have been constructed of sufficient capacity for the entire future population. The other parts, which are capable of easy enlargement, are of a size for dealing with a population about 50 per cent. more than the present.

When the sewage reaches the works through the last length of sewer it passes through a strainer, made of iron rods, into the pump chamber. The strainer effects the removal of large matters, such as corks, cabbage stalks and the like. The sewage then enters the pump chamber, in which are three sets of single-acting plunger pumps designed for lifts of 43 ft. They are driven by three 50 horse power compound horizontal intermediate receiver condensing engines.

Each set of pumps with its engine is capable of rais-

ing about 4,000,000 gallons of sewage in a day, the three together being therefore capable of dealing with 12,000,000 gallons per day. Each set of pumps can be worked separately, one of them being sufficient for dry weather, a second set being brought into use in wet weather, while the third is held in reserve in case of accident to either of the others. Space is provided for the accommodation of two more similar sets of pumps and engines, if in future they should be required. Steam is supplied for all the machinery by three Galloway boilers, each 18 ft. long by 6 ft. 6 in. in diameter, set on Livet's system, any one of which will supply sufficient steam for doing the fine weather work, the other two being available when wanted. Weighbridge, trucks and a steam crane for unloading coals and chemicals at the dock and wharf and conveying them into the buildings are all provided.

When the sewage rises to a certain height in the sewers and the pump chamber, the fact is communicated by an automatic arrangement of electric bells to the foreman's residence and to the engine room and attention called thereto, thus avoiding any chance of overcharging the sewers. The strained sewage flows continuously into the pump chamber, where it receives a small dose of milk of lime from the vats in one of the chemical mixing rooms. It is then pumped to the surface, the operation of pumping also serving to thoroughly mix the sewage and the milk of lime together. The partially treated sewage then flows from the delivery pipes of the pumps by a covered channel into the inlet channel for treated sewage. At the head of the channel is a close iron bar strainer which removes any large matter that may have passed the first strainer. On its way to the channel the sewage passes through the second chemical mixing room, where it receives a dose of a solution of sulphate of alumina, carbon and iron, and is thoroughly mixed therewith by an agitator placed in the angle of the chemical room. This channel is supported on arches to raise it to the required level to command the whole of the precipitating tanks. Starting from the mixing room it is carried on three arches to the tanks. Here it turns right and left, extending the entire width of the eleven tanks. Between the inlet channel for treated sewage and each tank there is, however, a second inlet channel which communicates with the first by means of valves, which can be opened as required. When one of these valves is opened the inlet channel of one tank is allowed to fill up with treated sewage to the level of a weir forming the outer side of the channel. The sewage then flows over this weir until the tank is filled or the valve is closed. A 15 in. scour valve enables the inlet channel to be completely emptied when desired. The treated sewage channel is covered with tiles set on cement slabs, carried by H beams, spaced 3 ft. apart.

The treated sewage is admitted continuously into one or more of the precipitation tanks, as required As the tanks fill precipitation takes place, the precipitate rapidly falling to the bottom, while the effluent water, now deprived of the whole of its polluting matter in suspension, and nearly all of that in solution, flows continuously over weirs at the other end of the tanks. This effluent water is sufficiently pure to be discharged direct into the river, and can be passed thereto by the only outlet provided at the northeast corner of the works.

The effluent water is, however, raised to a higher degree of purity, whenever required, by filtration through filter beds constructed of layers of various sized gravel, sand and carbon; the surfaces being covered with a thin layer of agricultural earth sown with grass. The precipitation tanks are emptied of their entire contents once a day, and when a tank has to be emptied, it is shut off from the inlet channel for treated sewage by valves and allowed a short time for repose. The water is then drawn off from the tank by a floating pipe, the upper portion of the water, owing to the levels, being discharged on to the high-level filter beds and the lower portion on to the low-level filter beds by the pipe shown in section. Two 10 in. sluice valves enable the flow to be directed into either pipe. There are valves between the channels and the filters. The discharge from both filter beds will flow into the Thames by gravity, except for a short time at spring tides, when the river is also filled with land water. It may be necessary at such a time to pump it, and for this purpose there are provided a pair of large Worthington steam pumps.

The floors of the filters are laid practically level, and the effluent finds its way through a number of drainage pipes into the delivery channel for effluent water. This channel can be shut off from the river and connected to the sumph from which the filter pumps draw.

The precipitate (commonly termed "sludge") at the bottom of a tank averages from 2 in. to 3 in. deep, being nearly all or 90 per cent. water. The water drawn off from the tanks and passed away to the filters or to the river direct is not, however, lowered quite down to the precipitate or sludge; the water immediately overlying the sludge, for a depth of 6 in. or 7 in., being retained with the sludge. The bottoms of the tanks slope at 1 in 60, so as to form channels, and the sludge and water last mentioned run together, aided by sweeping, into a covered sludge passage passing along the upper ends of the tanks behind the inlet for treated sewage. Thence the matter passes into the sludge chamber beneath the press-house.

In this sludge chamber precipitation still rapidly takes place, and the water which rises to the top of the sludge is drawn off by a floating pipe. It is not, however, allowed to pass to the filter beds or to the river, but flows back again into the pump chamber, mixes with the sewage and is treated over again. The quantity of water thus dealt with is comparatively very small. The sludge, having thus been deprived of some of its water, and brought into a favorable condition for pressing, is lifted by pumps into iron receivers placed in the press-house.

These receivers each contain a charge for one press. In these it is limed, that is, a certain small quantity of lime is added to it so as to facilitate the operation of pressing, and it is forced by rams into the presses. The water pressed out of it (again a comparatively small quantity) passes to the pump chamber and mixes with the sewage to be treated over again, and the solid "sludge cakes," measuring 3 ft. square by 1¼ in. in thickness, are removed from the presses.

This work is done by three of Messrs. Johnson and Hutchinson's 36 in. square sludge presses, each containing thirty plates and chambers. They are provided with all requisite sludge pumps, forcing rams, liming and skimming apparatus. The various parts of this sludge-pressing machinery are provided in duplicate in case of accident. Sludge in this pressed condition occasions no nuisance whatever, and may be stacked and stored without creating even an annoyance. For agricultural purposes it has a manurial value rather higher than that of the best farmyard manure. The quantity that will be produced from the present population will be about 10 tons daily, and considering the very great demand for manure of all kinds by the market gardens surrounding the locality, there will be no difficulty in disposing of it. Pressed sewage "sludge cake," which contains about 50 per cent. of water, is exceedingly suitable for making up and raising low-lying land, and the Board will be able to utilize much of it for improving their own property.

The entire cost of the works, including the sewers, will amount to between £115,000 and £120,000, the exact outlay being not yet ascertained. The annual cost of carrying on the work, including pumping the sewage, is estimated at £3,480, and this, together with the repayment of capital and interest, will not, it is expected, exceed a rate of 7½d. in the pound for the entire cost.

The contractors who have completed the sewers are Messrs. Nowell & Robson, of London, and the pumping station and precipitation works have been completed by Mr. William Webster, also of London. The contractor who commenced the works was Mr. C. Dickinson. The pumps, engines, boilers and mixing machinery have been supplied and erected by Messrs. James Simpson & Co., of Pimlico. The pressing plant and machinery have been supplied and erected by Messrs. S. H. Johnson & Co., of Stratford, E.

The engineer-in-chief was Mr. J. C. Melliss. Mr. James McKie filled the post of resident engineer, and Mr. W. Fairley has been appointed to the management of the works.

THE "SLEEPING SICKNESS" OF WEST AFRICA.

DR. H. GRATTAN GUINNESS, of London, has recently visited the Congo Free State, and writes home to Dr. Patrick Manson concerning the "sleeping sickness," as it is termed among the negroes living along the river Congo. He had an opportunity to investigate the symptoms of twelve or more typical cases. He examined the blood in each of these cases, and found that filariæ were present in all. The most intelligent and brightest members of their tribe or village are frequently among the first to be taken down. Active workers become lazy, or, more properly speaking, indisposed to labor, in consequence of the approaching hebetude peculiar to this disease, and then grow physically feeble. They rapidly deteriorate mentally, and frequently there are developed a stubbornness and perversity which weary out their friends. This is especially true of those who refuse to admit that they have been smitten with the malady, though it is all too evident to others. Insidious somnolent symptoms commonly first attract the attention, but perhaps more frequently there is observed a change of countenance, a lackluster state of the eyes and skin, a puffiness of the cheeks, and a loss of brightness or keenness of perception and attention.

The maniacal form of the disease is quite rare. At a village called Banza Manteka there have been a hundred deaths among the natives by this disease, and in only four of the cases was there a maniacal history. One of these may have been a case of febrile delirium, as death was believed to have occurred from high fever and neglect; the three other victims probably were starved to death.

Thus far the foreigners, whether white or colored, have been exempt from the disease. Dr. Guinness did not find that the disease was known in the towns nearest to the coast. The greatest known prevalence is reported from a village about one hundred and fifty miles up the river Congo. One case only of sleeping sickness has been seen and studied on English soil, and that was the case of a person who died recently at the London Hospital, a patient of Dr. Stephen Mackenzie's. He was a young negro from the middle Congo, who, recognizing the nature and almost certainly fatal issue of his malady, traveled upward of six thousand miles to offer himself, and his body after death, for the benefit of science and of his suffering fellow tribesmen, his hope being that the English physicians might be enabled to study out the ætiology and prophylaxis of this hitherto incorrigible disease. Dr. Mackenzie has reported to the Clinical Society of London the fact of the occurrence of the *Filaria sanguinis hominis* in the case of this heroic young man, but beyond that item of information no particular advantage has thus far been reaped from his long journey. To this discovery of the filaria Dr. Mackenzie attached very little importance, and in this opinion he was supported by Dr. Patrick Manson, whose authority is exceptionally high in such a matter, and who expressed the belief that the association of filarial infection with the morbid somnolence was non-essential and fortuitous. Whether this opinion will be persisted in when the findings of Dr. Guinness, above referred to, come to be weighed, remains to be seen.

Professor Ludwig Mauthner, of Vienna, has called attention to the reported frequency of ptosis as a symptom of sleeping sickness. Ptosis was present in the London Hospital case, and thus confirms the following theory of Mauthner's, as well as the casual statement of Dr. Junker, the African explorer, that this symptom is an important one, and is held by the African doctors to be a marked prognostic of the onset of lethargy. Mauthner's designation of the malady is "a chronic endemic morbid somnolence of the negro," and his interpretation of its causation is that it is an inflammatory process affecting cerebral motor areas. In this view, it is a *poliencephalitis superior*, an inflammation of the central gray cavities of the third ventricle, the gray matter of the walls of the aqueduct of Sylvius, and the floor of the fourth ventricle, these being correlative to the apathy, depression, muscular enfeeblement, and lethargy, while an extension of the process of inflammation to the nuclei of the efferent cranial nerves would give rise to the focal symptom of ocular paralysis, inclusive of ptosis. In the absence of an ascertained pathological lesion different from the foregoing, Mauthner's explanation constitutes the most reasonable hypothesis that has hitherto been presented. The endemic nature of the disease is accepted by Hirsch, Corre, Manson, and some others, but that it is not malarial in origin seems to be demonstrated by the fact that, while the Europeans living in the region where this sickness occurs contract the malarial fevers which are abundantly prevalent in the Congo valley, the blacks only are subject to the lethargy. The London Hospital patient gave no history of malarial infection, and an examination of the blood for the *Plasmodium malariæ* had a negative result. Dr. Manson is inclined to the belief that the disease will be found to be a food disease. The traveler Stanley has suggested that the uncooked manioc is the cause of much sickness and death among the natives.—*N. Y. Med. Jour.*

THE MANUFACTURE OF NITRO-CELLULOSE.

By Dr. J. B. LITTLEWOOD.

GUN-COTTON is obtained by the action of nitric acid, in the presence of sulphuric acid, upon the purest cellulose—cotton fiber—and is a substitution product. According to the treatment followed—the strength of the acids, etc.—are obtained mono-, di-, tri-, tetra-, penta-, and hexa-nitro compounds. These are termed soluble and insoluble, according to their solubility in alcoholic ether. The equation illustrating the reaction has been written for tri-nitro-cellulose:

Cotton. Nit. Acid. Gun-cotton. Water.

$$C_6H_{10}O_5 + 3HNO_3 = C_6H_7(NO_3)_3O_5 + 3H_2O$$

A number of these substitution products are known; the soluble varieties being used for collodion; the insoluble as explosive agents, generally the tri-nitro.

The process consists essentially in exposing the dried cotton for a sufficient length of time to the action of a mixture of nitric acid (sp. gr. 1·45 to 1·50) with sulphuric acid (1·84 to 1·85), and in then thoroughly washing the fiber to remove all free acid adhering thereto.

The fiber has been submitted in all forms, from the carded mass or hank to the finest impalpable powder. This powder has been obtained by both chemical and mechanical means—by cuprammonium and by grinding. The reasons for comminution of the cotton are that when the cotton is subjected to the action of the acids in its natural state and length of fiber, the line of least resistance seems to be by way of the inside of the tubes constituting the fiber of the cotton, into which they are taken in part by capillary attraction, subject to change themselves as they progress, and to increased resistance from any oil or gum, etc., in their progress, and therefore to modified action, the result of which is slower and slower, and otherwise more and more imperfect chemical change. It may also be that the power of capillary attraction is balanced in the tubes by air contained therein sufficiently to prevent the acids from taking effect.

It has also been customary to wash the cotton in alkaline baths, rinse and dry before steeping in the acid mixture, and whatever alkali was not neutralized would effect the nitration.

The cotton fiber has for its protection a glazed surface, as if it were enameled by nature. It is tubular and cellular in structure, and contains a natural lubricating semi-fluid substance, composed of characteristic oil or gum, or water, or other material, or a combination thereof. Both the glaze and the lubricating substance, as well as the fineness of the fiber, vary with the soil, climate, and other accidents of growth. Where cotton waste is obtainable, this is cleansed for the purpose of conversion, and unless carefully treated, there is liability of variable nitration of material thus obtained. Where yarns and hanks are employed it has been found that the twisting of the fiber and the disposition in the yarn form caused a resistance to the penetration and to the action of the acids, with the result that parts of the fibers were not acted upon, or acted upon imperfectly.

The same difficulty has been observed where paper has been expressly prepared from cotton fiber for conversion. In this last case the fiber is, of course, modified by the chemical and mechanical treatment which it has undergone in the preliminary preparation of the paper; but if the adherent oil or gum or glaze has been attacked, or if all have been removed by subsequent washing, etc., which is very difficult, if not impossible, the character itself seems to have been altered to such an extent that the cellulose product of the paper process is not uniform, or always otherwise satisfactory.

Fiber has been treated with sulphuric acid prior to nitration, and in this way the material has the character of vegetable parchment imparted to it before it is subjected to the bath of mixed acids. The fiber is washed and dried in this case before nitration.

Where wood is used as the form of cellulose it is necessary to comminute or disintegrate it, and by boiling in presence of alkali under pressure to remove sap, resin, and salts; then washing in a poacher with pure water; beating, straining, and drying. This fibrous pulp is submitted to the usual bath of nitric acid at 1·40 to 1·50 (one part) with sulphuric acid at 1·80 to 1·84 (two parts). The fiber is kept in this bath of cooled acids twenty-four to thirty hours, with occasional agitation, squeezed, and thoroughly washed, steeped in alkali; again washed and dried.

The washing is performed at Newport by repeated passage through a wringer, which is so mounted that the water pressed out is led away, the squeezed gun-cotton falling into fresh water, and in this way a more thorough purification is obtained, in a shorter time, than by the ordinary method of very long exposure to the action of running water.

The Abel method of washing included the use of a pumping engine or beater, where the fiber was submitted to a revolving wheel carrying projections which passed between stationary projections on the bottom of the tub, and thus became fully torn, and from this beater the pulp passed to a washer (poacher), where the pulp was stirred for a long time with large quantities of water. The revolution of the wheel in this tub prevented deposit in any part of the tub.

At Stowmarket an artificial cascade is made by leading a stream of water along a trough, and allowing it to fall from a height into the washer. The gun-cotton

is thrown on the falling stream and immediately carried deep down into the vessel, the agitation being further promoted by the workmen. In this way the cotton comes in contact with such a large quantity of water that the rise in temperature is inappreciable, and the pyroxyline almost altogether free from acids. But, to perfect the washing, the pyroxyline is passed through the centrifugal machine and then thrown into tanks, where it is subjected to the action of water for one to three weeks, and is afterward boiled in large vats below 212° F. These washings may be followed by the addition, or use in them, of alkaline material.

Oxidants may be added to the fiber before drying, and it may be pressed into the form of slabs, cylinders, or pellets.

Unmixed with salts, it may be stored in this wet condition, and is then the safest of all explosive agents. It is not liable to be fired by a spark or flame, nor is affected by blows, friction, or other rough handling. The only care necessary is that the cakes be not frozen. The proportions of acids used vary from one of nitric with three of sulphuric to one to two (as at Le Bouchet). Abel's method (British) and that in use at Newport are alike in using one to three. At the torpedo station either raw or carded cotton is used. It is first steeped in a weak solution of carbonate of soda, to remove the resin from the raw cotton, or the oil from the carded, then washed and carefully dried. The acids are the strongest nitric and sulphuric. A large quantity of the mixed acids is placed in the leaden pan, and into this a small quantity of the dried cotton is immersed. When thoroughly saturated, the cotton is lifted upon a reticulated shelf over the pan to drain. It is then pressed, placed in an earthen jar, and when this is half full of the dipped cotton, fresh acid is poured upon it until the cotton is covered. It is then set where the temperature may be kept reduced for forty-eight hours. The greater part of the conversion takes place at the dipping, but that it may be complete it is necessary that the contact with the acids should continue for the time stated. When the cotton is removed from the first bath, a quantity of fresh acid equal to that removed with the cotton is added before a fresh batch is treated.

At the end of the time stated the cotton from the jars is passed through rubber or leaden wringers.

Where equal parts of the concentrated acids were used, the acids from the first batch were used once again, the time of immersion being extended. In other cases the spent acids are restored in bulk by the addition of a suitable quantity of a nitrate and sulphuric acid, thus employing the acidulous mixture continuously in the conversion of successive batches of material. In this case, by using a nitrate the base of which forms, when introduced into the bath, an insoluble compound, the bath becomes clarified by subsidence of the precipitant. In other cases the spent acid is treated to free it from flocculent matter, after which it is restored by means of fresh acids, and so utilized. The proportions of cotton to acid vary from 1 to 6 up to larger baths. At Waltham Abbey the cotton in 1 lb. quantities is dipped into a 12 gallon pan of the mixed acids.

The same acids have been used again for treatment of successive batches without strengthening, except the addition of such a quantity of acid as may be required to properly cover the fiber. Again, the spent acid has been analyzed to ascertain its condition, and an amount of fresh acids mixed therewith sufficient to restore it for use. Spent acids are in some cases used for the first dipping, followed by a bath of the concentrated acid in usual proportions to fully complete the nitration. Nitration has also been effected by addition of a part only of the acid required for conversion; allowing reaction, and passing the material into additional quantity of the acid required to complete. It has also been effected by immersion of the cotton in a series of tanks, beginning with that having the weakest acid, and following until the fiber has been fully nitrated. As soon as the acid of the first vat falls below the required strength it is replaced by fresh, full-strength acid. This is operated by having the vats on a turn-table, passing the acids pressed out back to the vat from which they were taken. In this way all the suitable properties of the acid are utilized, the weakest acids becoming weaker by the partial conversion of the cotton which they effect, while the last immersions of each charge of cotton are in the strongest acid. This latter plan was to render available all the valuable properties of the acids, and enable the use of such acids until they have become entirely spent, in lieu of the usual way of treating the cotton by repeated immersion in the same acids, or by successive immersions in different receptacles, where the weakened but not entirely spent acid is thrown away.

Earlier the spent acids were used only for the manufacture of the weaker kinds of powder, to economize the cost of manufacture.

A CRYSTALLINE ALBUMINOID FROM OATS.

THE albuminoids which may be extracted from the oat kernel by various solvents are many, and their distinguishing characteristics are few; different solubility and different coagulation temperatures being about the only data for pronouncing them different substances.

In a long paper upon the albuminoids by Mr. T. B. Osborne, it is stated that by using a 10 per cent. solution of sodium chloride at 60° to 70°, Mr. Osborne has extracted an albuminoid which stands by itself among all others, for it can be crystallized.

The ground oats are treated with a 10 per cent. solution of sodium chloride, strained through a hair sieve to remove the husks, and heated to 60° for a hour. This extract is then filtered as rapidly as possible, and after decanting from a deposit which separates out on cooling, is saturated with ammonium sulphate; the precipitate is filtered off and added to the deposit formed on cooling. The substance thus obtained is treated with three liters of 10 per cent. sodium chloride solution at 65°, and filtered as quickly as possible on a hot water funnel, the filtrate being received in a vessel itself standing in a water bath at 70°. This liquid is allowed to cool very slowly, and when cool is decanted from the dense deposit that adheres firmly to the bottom and sides of the beaker. The said deposit is washed, first, with 50 per cent. alcohol, until the washings contain no more chlorids, then with absolute alcohol, and finally with ether; drying over sulphuric acid completes the preparation. By this method the author obtained 8·5 grms. from 5 lb. of oats.

The new albuminoid is a dense, snow-white powder when washed and dried, but, while wet, as deposited, it consists entirely of spheroids about 0·01 mm. diameter. It dissolves to an opalescent solution in cold distilled water, and is precipitated again on addition of a little sodium chloride, but redissolves on further addition of this salt. It dissolves to a perfectly clear solution in hot distilled water, and is partially deposited on cooling. It melts when treated with hot dilute alcohol, and remains suspended in the solution in transparent droplets, which dissolve on addition of a little salt and acetic acid; the solution sets to a transparent, bulky jelly on cooling.

The separation of this substance in spheroids naturally suggested to the author the possibility of crystallizing it, and his attempts to do so proved successful, perfectly formed octahedral crystals, which were pronounced by an expert to be isometric, being obtained. The procedure was as follows:

The albuminoid was dissolved in cold distilled water and sodium chloride was very cautiously added until a copious precipitate resulted. On immersing the test-tube in warm water, the precipitate dissolved to a perfectly clear solution, which was allowed to cool slowly in a bath containing about four liters of water at 60°. After a day the deposit was examined under the microscope, and found to consist entirely of crystals.

Inasmuch as the above method of obtaining the crystals is open to some objection on account of the use of salt, with its accompanying impurities, the author saturated distilled water at 60° with the albuminoid, and allowed the solution, surrounded by a large volume of warm water, to cool slowly: an abundant deposit of octahedral crystals was obtained, but they were not quite so perfectly developed as those just described.

Analyses of this substance in the form of spheroids show that its composition is very similar to that of the other albuminoids, among which it ranks with those that contain most nitrogen, 17·8 per cent. Its ash is 0·19 per cent.

Such is the discovery which Mr. Osborne announces he is following up. Emil Fischer has shown us how to make heat producers; we cannot be satisfied until we can make flesh formers.—*Chem. Tr. Jour.*

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